4.3 GEOLOGY AND SOILS

4.3 GEOLOGY AND SOILS

INTRODUCTION

This section comparatively examines the potential for geological and soils impacts associated with implementation of the OCMP and project alternatives. The main issues addressed in this section include:

- potential for damage from seismic shaking;
- impacts related to slope stability, erosion, and sedimentation;
- potential for erosion from surface water discharge, including "pit capture"; and
- decreased availability of aggregate resources.

The geologic and soils conditions within the lower Cache Creek basin present important controls on the feasibility of the mining and reclamation plans developed under the OCMP. The geologic setting of the area provides the opportunity for sand and gravel deposition and, therefore, aggregate mining. The transport and deposition of high-quality aggregate by Cache Creek result from a complex fluvial system that is influenced by active tectonics and geologic structure. The same system is responsible for the deposition of fine-grained overbank deposits on which valuable agricultural soils are developed.

The following summary of geologic and soils information is based on published geologic reports and maps for the region, a site reconnaissance, site-specific reports prepared by consultants for mining projects within the lower Cache Creek basin, and the Technical Studies for the Cache Creek Resource Management Plan (EIP et al., 1995). The available geologic and geomorphic data were reviewed by the Draft EIR preparers and were found to be generally consistent with appropriate engineering and geologic methods and standards.

SETTING

Description of Regional Environment

Geology

The planning area is located on the western margin of the Sacramento Valley, the northern portion of the Great Valley Geomorphic Province of California. The Sacramento Valley is a large structural trough formed between the Coast Ranges to the west and the Sierra Nevada to the east. The Valley is filled with a thick sequence of sedimentary rocks and sediments that range from Upper Jurassic age (150 million years old) marine rocks through modern alluvial deposits. The sedimentary sequence was apparently deposited on igneous and metamorphic basement[1] rocks of the Sierran structural block.

The Coast Ranges are actively being deformed by compressional forces related to relative movements of the Pacific and North American tectonic plates. These forces resulted in development of major faults and folds (oriented N30W) in the Cache Creek basin. The Coast Ranges began uplifting about 3.4 million years ago, resulting in a eastward tilting and erosion of Cretaceous Great Valley Formation, and younger Tertiary sedimentary rocks overlying the Franciscan basement bedrock. Sedimentary rocks eroded from these uplifted ranges were deposited as the Tehama Formation until about one million years ago, when continued eastward tilting uplifted the Tehama Formation (NHC, 1995).

The western margin of the Sacramento Valley represents a major geologic boundary between the Coast Range structural block to the west and the Sierran structural block to the east. This regional boundary, typically referred to as the Coast Range-Sierran Block Boundary Zone (CRSBBZ), has been the subject of recent geologic and seismic research; it is interpreted to represent not only a regional geologic and geomorphic boundary but a regional fault or suture zone (Wong and others, 1988).

The higher mountains that define the modern (i.e., current) range front of the Coast Ranges are separated from the Sacramento Valley by a northwest-trending set of low hills. The hills include the Dunnigan Hills, which extend from near the town of Dunnigan to the north to just south of Cache Creek. The relatively lower southward extension of the Dunnigan Hills is referred to as the Plainfield Ridge. The low hills have long been recognized as representing a block of older alluvial deposits uplifted above the surrounding younger alluvial deposits (Bryan, 1923).

Recent research (Unruh and Moores, 1992) indicates that the low hills east of the Coast range front have formed as the result of active folding and thrust faulting caused by compression across the Coast Range-Sierran Block Boundary. The folding and faulting deform the Tehama Formation indicating that the deformation is middle Pleistocene (approximately one million years ago) or younger in age.

The position of ranges of hills in the region generally correspond to upward folds called anticlines. The folding has also resulted in the formation of structural valleys (called synclines). Within the study area, Cache Creek crosses the Madison Syncline, the Dunnigan Hills Anticline, and their associated faults. Active folding at the Madison Syncline and Dunnigan Hills Anticline have contributed to the historic channel profile of Cache Creek and may affect the elevation and gradient of subsurface groundwater. The Dunnigan Hills have been uplifted approximately 90 meters (297 feet) since the beginning of compressional deformation 200,000 to 400,000 years ago. The average rate of uplift, therefore, has been approximately 0.2 to 0.5 millimeter (0.008 to 0.018 inch) per year

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[1] "Basement" rock is a general geologic term for the deepest known bedrock.

(Munk, 1993). Subsidence of the ground surface has been observed east of the Dunnigan Hills in the vicinity of the City of Woodland. The subsidence is likely related to high rates of groundwater withdrawal from the underlying aquifer. The approximate amount of subsidence measured in this area during the period 1942 to 1987 was -2.25 feet (NHC, 1995).

The Madison Syncline comprises the northwest-trending structural valley, Hungry Hollow, separating the Dunnigan Hills-Plainfield Ridge from the Capay Hills. This structural valley is filled with Pleistocene and younger alluvial sediments that are up to 150 feet thick. The sediments that fill Hungry Hollow were transported to the area and deposited by Cache Creek.

The headwaters (source) of Cache Creek are located in the upland area of the Coast Ranges to the northwest. The upstream reaches along Cache Creek contain areas of active erosion that are the primary sources of sediment supply, which are transported and deposited downstream. The Creek flows southeastward through the Capay Valley to the southern end of the Capay Hills. From the town of Capay, the Creek flows eastward across Hungry Hollow. Through this reach, the Creek is a wide, braided stream with a relatively low gradient. At the eastern margin of Hungry Hollow, the Creek flows in a more constricted, higher-gradient reach through the southern Dunnigan Hills. The Creek then widens and the bed slope decreases as it emerges onto the Sacramento Valley near the town of Yolo.

Seismicity

The tectonic setting of western California creates a relatively high potential for the occurrence of moderate to large earthquakes. Large earthquakes can cause damaging ground shaking throughout a large area. The active and potentially active faults potentially affecting the planning area are shown on Figure 4.3-1. The characteristics of these faults are summarized in Table 4.3-1.

In general, the regional fault zones, including the San Andreas, Hayward, Calaveras, and Rodgers Creek fault zones, are typically characterized as strike-slip faults with the major component of movement being horizontal and right-lateral.[2] Moderate to large earthquakes (M 5[3] or greater) are considered capable of causing rupture of the ground surface. Major right-lateral strike-slip earthquakes (M 7 or greater) within the region in historic time have occurred on the San Andreas (1838, 1906, 1989) and on the Hayward faults (1836, 1868). These earthquakes were felt over large areas. Western Yolo County experienced

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[2] Right-lateral motion is a convention defined by the observation of the direction of movement across the fault when looking across the fault. Within the San Andreas Fault Zone, the observer would recognize that the western side of a fault has moved northward after right-lateral displacement along the fault.

[3] M 5 denotes Richter Magnitude 5.

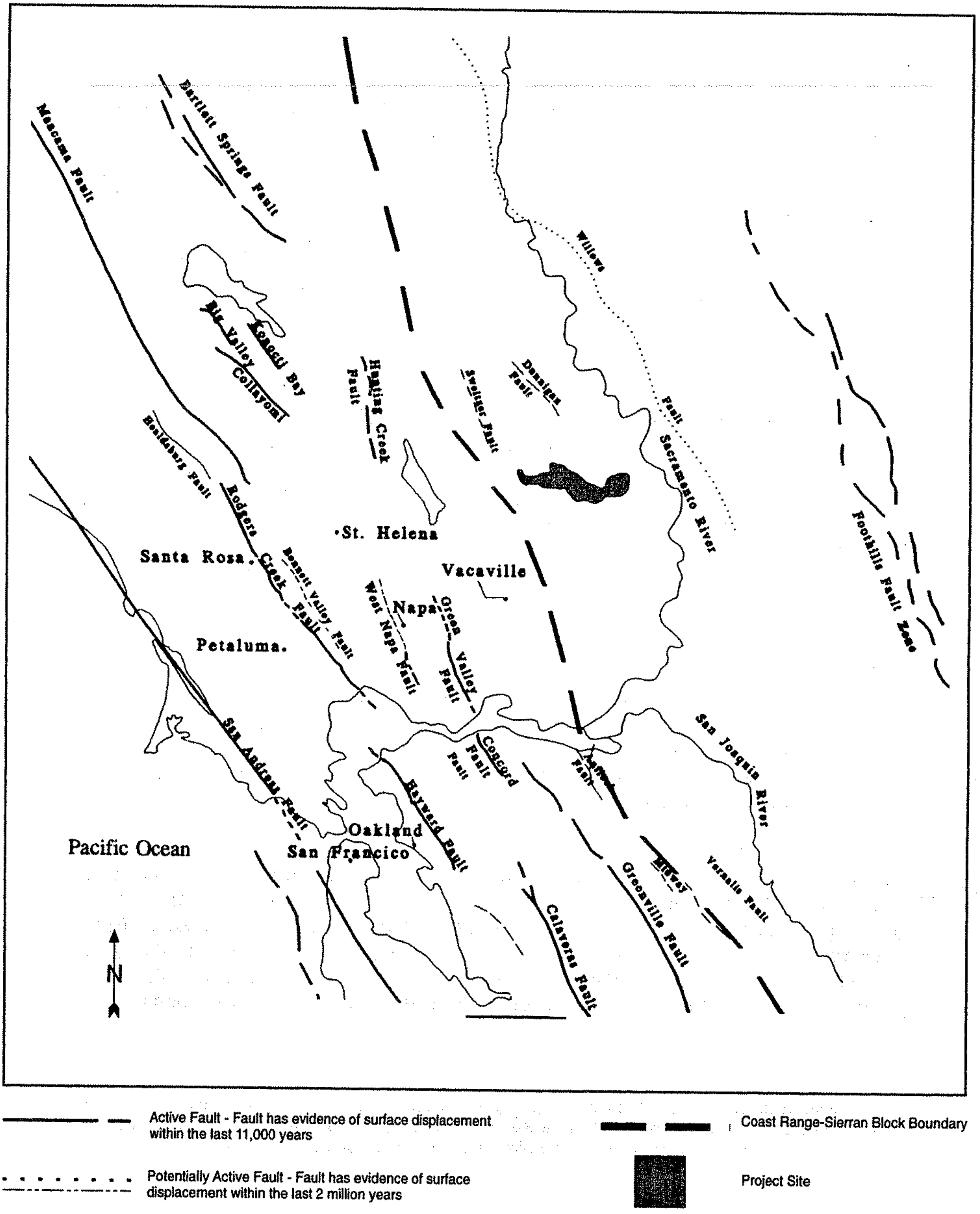

Figure 4.3-1 Regional Fault Map

SOURCE: JENNINGS, 1994; MUALCHIN AND JONES, 1992

TABLE 4.3-1: Major Faults Potentially Affecting the Project

Fault	Approximate Distance from Planning Area (miles)	Maximum Credible Earthquake[1, 2] (M_L)	Recurrence Interval[3] (years)	Expected Maximum Peak Ground Acceleration during MCE[4] (g)	Expected Ground Shaking Intensity at the Site (MMI)
Bartlett Springs	49	6.75	NA	0.04	VI
Big Valley Fault	50	6.25	2,675	0.04	VI
Konocti Bay Fault Zone	41	6.25	NA	0.05	VI
Maacama Fault Zone	41	7.25	696	0.08	VII
Hunting Creek	22	6.75	NA	0.12	VII
Rodgers Creek-Healdsburg	43	7.0	255	0.07	VII
Hayward Fault	50	7.5	264-556	0.08	VII
West Napa	30	6.5	NA	0.07	VII
Foothills	43	6.5	NA	0.05	VI
Green Valley	25	6.75	424	0.10	VII
Coast Range-Sierran Block Boundary Zone	8	7.0	600-1200[5]	0.31	VIII

Notes: NA = Data not available.
MMI = Modified Mercalli Intensity.
g = acceleration of gravity.

[1] The maximum credible earthquake (MCE) is the largest earthquake expected under the present geologic framework.
[2] Estimated magnitude of MCE from Mualchin and Jones (1992), except where noted.
[3] Recurrence interval, or repeat time, is the estimated interval of time between maximum credible earthquakes (Wesnousky, 1986).
[4] Expected maximum peak ground accelerations are based on seismic shaking attenuation curves presented in Mualchin and Jones (1992).
[5] Estimate by Wakabayashi and Smith (1994).

moderate ground shaking (up to MMI[4] VII) during large earthquakes generated on these major fault zones to the west. The combined probability of a major earthquake (M 7 or greater) occurring on the major strike-slip faults of the San Francisco Bay region is estimated to be 67 percent (USGS, 1990). This probability represents a minimum because not all faults capable of generating a large earthquake (including the Calaveras and San Gregorio-Seal Cove fault zones) were included in the development of the estimate.

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[4] MMI denotes Modified Mercalli Intensity Scale.

The northern San Andreas fault system includes additional fault zones that could generate earthquakes, which could cause moderate to strong ground shaking within the planning area. The Maacama fault zone, extending from central Sonoma County to northwestern Mendocino County, is capable of generating a M 7.25 earthquake. The Bartlett Springs and Hunting Creek fault zones within the eastern Coast Range are additional seismic sources with the potential to generate M 6.75 earthquakes (Mualchin and Jones, 1992).

In the regional area, seven distinct segments of the CRSBBZ at the western edge of the Sacramento Valley have been identified as being capable of generating M 6 or greater earthquakes (Wakabayashi and Smith, 1994). These potential seismic sources include the North and South Dunnigan Hills fault segments identified in the region.

Interpretation of historic records for earthquakes affecting central California indicates that possibly eleven earthquakes of M 6 or greater have been generated along the CRSBBZ (Wakabayashi and Smith, 1994). An evaluation of more recent earthquakes (recorded by seismographs) indicate that the earthquakes of the southwestern Sacramento Valley region are characteristically caused by reverse or thrust faulting. Wong and others (1988) suggest that clusters of seismicity recorded within the western Sacramento Valley near Williams in Colusa County during the period 1980 to 1985 are representative of earthquakes on reverse faults. Their evaluation of recorded earthquakes for the period 1969 to 1985 also indicates clusters of seismicity beneath the Dunnigan Hills and in the area southwest of Madison. An M 4.2 earthquake near Madison in 1978 was also characterized as a reverse fault earthquake.

The maximum expected earthquake for the CRSBBZ is estimated to be an approximate M 7 event (Mualchin and Jones, 1992), which could occur on numerous known, suspected, or unidentified faults within the zone. The average recurrence interval (i.e., period between characteristic earthquakes) within the CRSBBZ is estimated to be 360 to 440 years. The North and South Dunnigan Hills fault segments are expected to generate M 6.1 and M 5.8 earthquakes. The estimated MCE for the potentially active Sweitzer Fault is M 6.5 (Unruh, et al., 1993).

In addition to the potential for earthquakes within the San Andreas fault system and the CRSBBZ, earthquakes along the Sierran Nevada Frontal fault system could occur. This fault system, developed along the western flank of the Sierra Nevada, includes the Foothills and Melones fault zones; that system has an estimated maximum credible earthquake of M 7.8 (Mualchin and Jones, 1992).

Description of Local Environment

Geology

The planning area is located on alluvial terraces along Cache Creek within Hungry Hollow and south of the Dunnigan Hills. These terraces have formed on a broad alluvial fan that has been deposited as Cache Creek emerged into the Sacramento Valley from the uplands to the east. The planning area is mapped (Helley and Harwood, 1985) primarily as active stream channel (Qsc) deposits (Figure 4.3-2), defined roughly as lying within the banks of the active channel, and young alluvium (Qa). Portions of the Planning area are underlain by basin deposits (Qb) and older alluvial terraces and fans of the Modesto Formation (Qmu). These deposits and related land forms are the result of incision of the Cache Creek channel into its own alluvial fan (Figure 4.3-2).

The thickness of Quaternary alluvial deposits overlying the Tehama Formation within the planning area is variable. Information from the boring logs for wells in the area provide information on the subsurface conditions (Luhdorff and Scalmanini, 1992). At the western end of the planning area, in the vicinity of the Capay Dam, the deposits are relatively thin (10 to 50 feet thick). The thickness increases westward to over 150 feet near the Capay bridge. The contact between the alluvial deposits and the Tehama Formation slopes upward in a downstream direction and the thickness of the deposits is reduced. As the creek traverses the Dunnigan Hills-Plainfield Ridge anticline, the alluvium is typically less than 25 feet. Downstream of the Dunnigan Hills, the thickness increases eastward to more than 300 feet in the vicinity of Interstate I-5. In general, the alluvium is more coarse-grained, comprised primarily of sand and gravel between Capay and the Dunnigan Hills. The alluvium east of the Dunnigan Hills becomes finer-grained.

Subsurface information available from borings and mining excavations made within the vicinity of central portion of the planning area provide more detail on the stratigraphy (i.e., layering) of the near-surface aggregate deposits. The uppermost overbank deposits are clayey silts and silty clays that extend from the surface to an average depth of six feet. The thickness of the fine-grained overbank deposits reportedly increases to the south, away from the Creek, to more than 20 feet (BASELINE, 1995). The fine-grained surficial deposits are directly underlain by two feet or more of sands and clayey sands,[5] which change gradationally downward to sandy gravels and gravels. These deposits are informally called the "shallow sand and gravel" and are, in some areas, underlain by a "middle clay." The top of the middle clay has been encountered at depths ranging from 21 to 38 feet south of Cache Creek. The thickness of the clay, where present, ranges from 8 to 13 feet.

The middle clay is underlain by the "lower sands and gravels." These coarse-grained sediments range in thickness from 12 to 30 feet. Where the middle clay is absent, the total thickness of sand and gravel deposits (including minor silt and clay layers or lenses) measured south of Capay Creek is 50 to 58 feet. The lower sands and gravels overlie the "bottom clay," where present. The depth to the top of the bottom clay ranges from less than 35 feet in some areas to greater than 65 feet in others.

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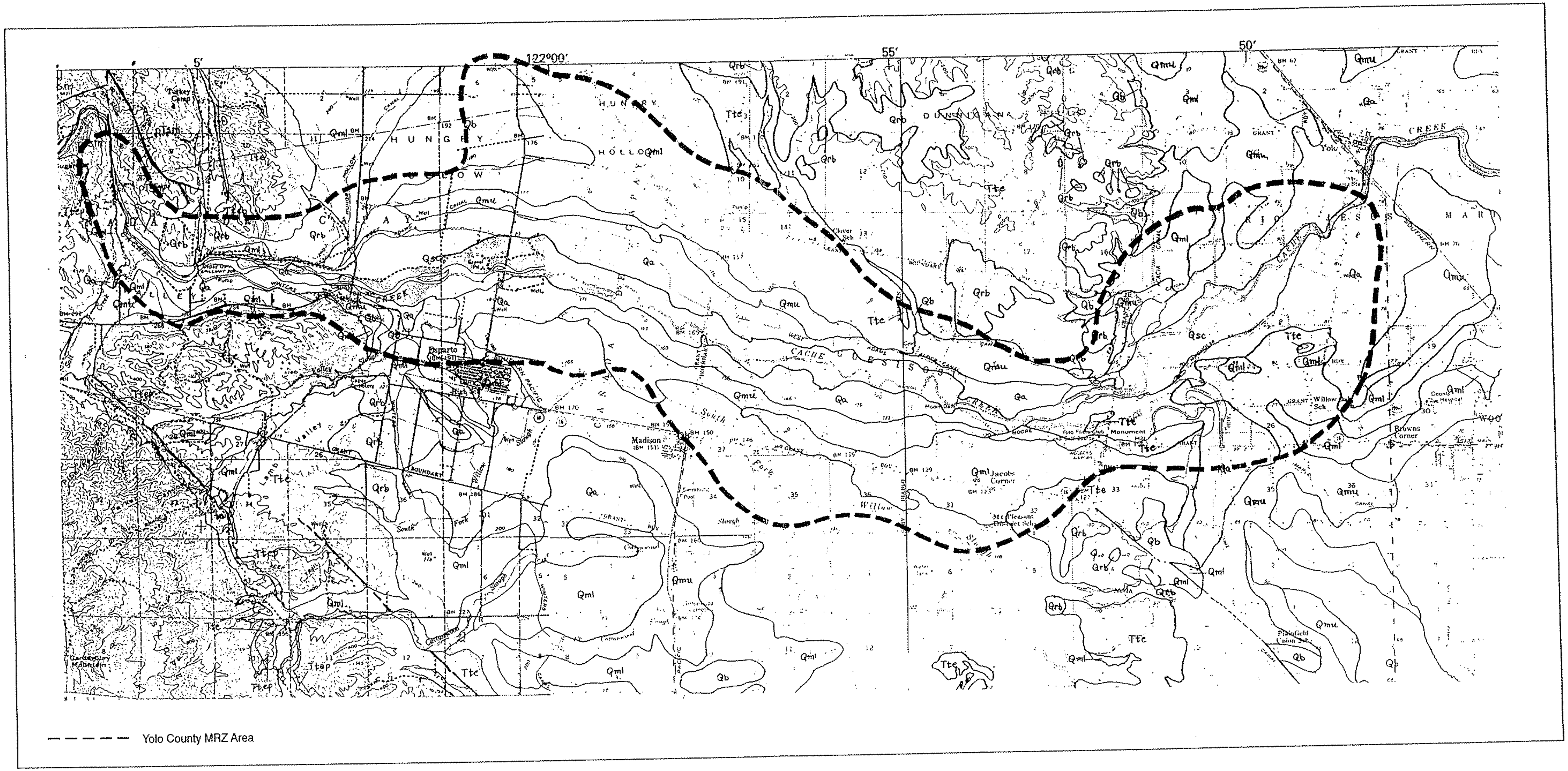
[5] The fine-grained silty, clayey, and sandy overbank deposits are not marketable aggregate products and are collectively called overburden, distinguishing them from deeper well-graded sand and gravel aggregate resources.



Holocene	Qsc	STREAM CHANNEL DEPOSITS: Deposits of open, active stream channels
	Qa	ALLUVIUM: Unweathered gravel, sand, and silt
	Qb	BASIN DEPOSITS, UNDIVIDED: Fine-grained silt and clay
Pliocene	Qmu	MODESTO FORMATION Upper Member: Unconsolidated, unweathered gravel, sand, silt, and clay
	Qml	MODESTO FORMATION Lower Member: Unconsolidated, slightly weathered gravel, sand, silt, and clay
	Qrb	RED BLUFF FORMATION: Thin veneer of distinctive, highly weathered gravels
Pliocene Pre-Tertiary	Tte - Ttep	TEHAMA FORMATION: Sandstone and siltstone with lenses of crossbedded pebble and cobble conglomerates. Putal Tuff Member: Poorly to well-sorted, moderately consolidated, vitric pumiceous tuff.
	Ptsm	METAMORPHIC, INTRUSIVE, AND SEDIMENTARY ROCKS

Figure 4.3-2 Generalized Geology Map

SOURCE: HELLEY, AND HARWOOD, 1985

The fine-grained surficial deposits, middle clay, and bottom clay represent overbank deposition from low-energy (slow-moving) water during and after flood events. These overbank sediments consist of clays, silts, and fine sands deposited on the margins of a stream. The sand and gravel sediments are higher-energy stream channel deposits. Migration, or shifting, of the channel can result in burial of overbank deposits (e.g., areas of where the middle clay or bottom clay is present) or removal (erosion) of these deposits.

The surficial Quaternary alluvial and stream channel deposits are composed of sediments primarily eroded from Franciscan, Great Valley, Tehama, and Cache Formations. The Franciscan Formation is located in the upper reaches of Cache Creek basin and constitutes a heterogeneous assemblage of rock types consisting of deformed volcanic and marine sediments. The important rock types of the Franciscan Formation that comprise gravels within Cache Creek include metamorphosed volcanic rocks, chert, greywacke (sandstone), and quartz. The Great Valley Formation is composed of various layers of greywacke sandstone, shale or siltstone, and conglomerate. The less abundant sandstones and conglomerates constitute important lithologies in the gravels of Cache Creek. The Tehama Formation consists of weakly cemented conglomerates and sandstones. The rock types of the pebbles in the conglomerates are comprised primarily of those of the Franciscan Formation. The Tehama Formation is exposed in the bed and banks of Cache Creek, most notably near Capay and Dunnigan Hills. The Cache Formation is similar to the Tehama Formation and is a likely an important contributor of gravel to Cache Creek. Tertiary to Recent volcanic rocks, common around Clear Lake, also may constitute 5 to 20 percent of the gravels in lower Cache Creek (NHC, 1995).

The surficial deposits of the Dunnigan Hills, located north of the planning area, are mapped primarily as the Pliocene Tehama Formation and the younger Red Bluff Formation. The Tehama Formation overlies the Great Valley Formation and as mentioned above is comprised of sandstones, siltstones, and conglomerates eroded from the Coast Ranges to the west. The Red Bluff Formation consists of a thin veneer of highly weathered gravels overlying the Tehama Formation (Helley and Harwood, 1985).

Soils

Soil, as described in this section, is the natural formation on the surface of the earth consisting of mineral and organic material. Soils can develop on unconsolidated sediments and weathered bedrock. The development of a soil is typically dependent on five major influences: climate, topography, biologic activity, parent material, and time. Differences in soil types are, therefore, caused by changes in these influences. Within the planning area, 33 different soils have been identified by the U.S. Soil Conservation Service (USDA, 1972) on the basis of characteristics that reflect relatively subtle but important changes in the soil formation factors. In general, the topography is relatively flat, the climate is similar, and biological activity is comparable. The major difference in the soils of the area is the topographic position relative to the active channel of Cache Creek and the associated differences in the consistency and age of the alluvial deposits. Mapping of the soil types, or mapping units, for the planning area is presented in Figure 4.3-3. The following discussion focuses on soil associations identified at the project site. Characteristics of soils and other soil mapping units, shown on Figure 4.3-3, are summarized in Table 4.3-2.

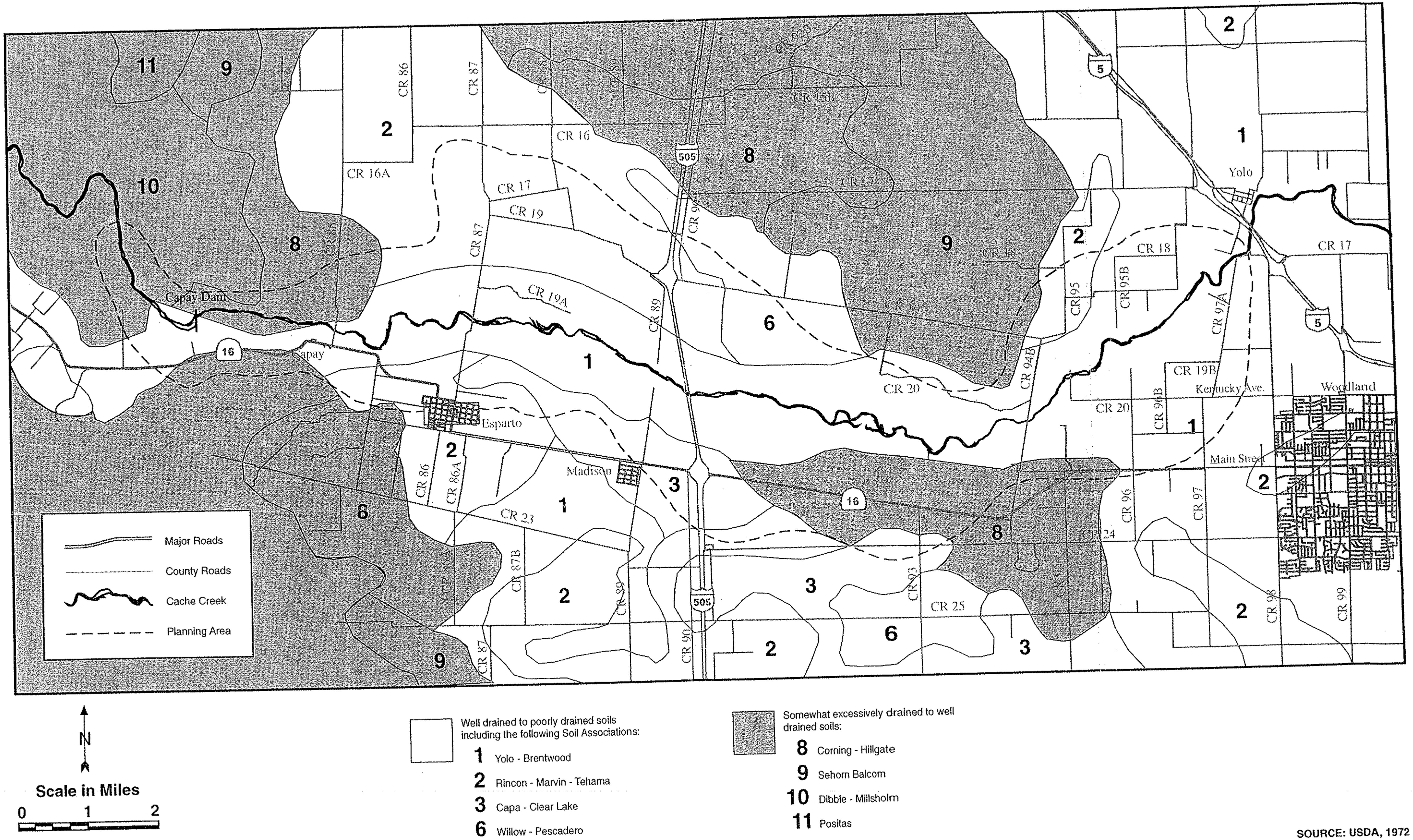
The surface soils that mantle the planning area are generally well drained to poorly drained soils on alluvial fans, basin rims, terraces, and in basins. The soils form in alluvium derived from sedimentary rock. Slopes range from zero to two percent. Soils in the planning area that are characterized by finer grained deposits such as silty clayey loam soils generally have a moderate to high shrink-swell potential and slow to moderate permeabilities. Coarser grained deposits that contain sands and gravels generally have a low shrink-swell potential and higher permeabilities. The soils in the planning area generally have a low or negligible erosion hazard if undisturbed (USDA, 1972).

The primary soil associations in the planning area are those of the Yolo-Brentwood association. These soils are generally well-drained, nearly level silt loams to silty clay loams on alluvial fans. Minor soils within the Yolo-Brentwood Association include Myers, Reiff, Sycamore, and Zamora. To a lesser extent, the planning area also contains soils of the Rincon-Marvin-Tehama and the Capay-Clear Lake association. The Rincon-Marvin-Tehama association soils are loams and silty clay loams that form on alluvial fans and basin rims; minor soils of this association include the Capay, Clear Lake, and Hillgate. The Capay-Clear Lake association soils consist of nearly level silty clays and clays that form on basin rims and in basins. The Sycamore soils occur to a minor extent in the Capay-Clear Lake association (USDA, 1972). The Storie Indexes for these soil associations are typically high, indicating relatively high agricultural productivity of the soils in the planning area.

Aggregate Resources

The Quaternary alluvial deposits of the Cache Creek area are recognized as a major source of aggregate for the production of concrete, asphaltic concrete, and road base materials. Aggregate mining has occurred in and along Cache Creek since the early 1900s. An estimated 80 to 90 million tons of aggregate have been removed from Cache Creek since the beginning of mining (Collins and Dunne, 1990). The majority of aggregate mined from the lower Cache Creek basin is suitable for the production of Portland Concrete Cement (PCC). The specifications for PCC-grade aggregate are more restrictive than specification for other aggregate products, criteria that increase the usefulness and marketability of these deposits.

A mineral land classification of aggregate materials in the Sacramento-Fairfield region conducted by the California Division of Mines and Geology (CDMG) (Dupras, 1988) presents an evaluation of the availability of aggregate resources within the lower Cache Creek watershed. Evaluation of aggregate resources throughout the State is required by the California Surface Mining and Reclamation Act (SMARA). Provisions of SMARA require that the CDMG determine the boundaries of major aggregate Production-Consumption (P-C) regions, identify aggregate resource areas within the regions, and evaluate the availability and supply of those resources. Assessment of the aggregate



SOURCE: USDA, 1972

Figure 4.3-3 Generalized Soils Map

TABLE 4.3-2: Soil Types - Physical Properties

Map Symbol	Soil Series Name	Shrink/Swell Potential[1]	Permeability[2] (inches/hour)	Erosion Hazard[3]	Corrosivity[4]
Most Common Soils:					
BrA	Brentwood silty clay loam	High	0.06-0.20	Slight to none	High
Ca	Capay silty clay	High	0.06-0.20	Slight to none	High
CtD2	Corning gravelly loam	Low to High	<0.06-2.0	Moderate	Low to High
HcA	Hillgate loam	Moderate to High	0.06-0.63	Slight to none	Moderate to High
Lm	Loamy alluvial land	N/A	N/A	Slight to none	N/A
Mf	Marvin silty clay loam	Moderate to high	0.06-0.63	Slight to none	High
Rg	Rincon silty clay loam	Moderate	0.2-0.63	Slight to none	Moderate
Rh	Riverwash	N/A	N/A	N/A	N/A
Sh	San Ysidro loam	Moderate to high	<0.06-2.0	Slight to none	Moderate to High
SmF2	Sehorn-Balcom complex	Moderate	0.2-0.63	Slight to Moderate	Moderate
Sn	Soboba gravelly sandy loam	Low	>20	Slight to none	Low
So	Sycamore silt loam	Moderate to high	0.2-2.0	Slight to none	High
TaA	Tehama loam	Moderate	0.06-2.0	Slight to none	Low to Moderate
Wm	Willows clay	Moderate	0.06-0.63	Slight to none	High
Ya	Yolo silt loam	Moderate	0.63-2.0	Slight to none	Low
Least Common Soils:					
BaF2	Balcom silty clay loam	Moderate	0.2-0.63	High	Moderate
BaE2	Balcom silty clay loam	Moderate	0.2-0.63	High to Moderate	Moderate
BdF2	Balcom-Dibble complex	Moderate	0.2-0.63	High	Moderate

TABLE 4.3-2: Soil Types - Physical Properties

Map Symbol	Soil Series Name	Shrink/Swell Potential[1]	Permeability[2] (inches/hour)	Erosion Hazard[3]	Corrosivity[4]
CtE2	Corning gravelly loam	Low to High	0.63-2.0	High to Moderate	Low
DbF2	Dibble clay loam	High	0.06-0.2	High	High
HdA	Hillgate loam	Moderate to high	0.2-0.63	Slight to none	Low to high
Ms	Myers clay	High	0.06-0.2	Slight to none	High
Pb	Pescadero silty clay	High	0.06-0.10	Slight to none	High
Rb	Reiff gravelly loam	Low	2.0-6.3	Slight to none	Low
SkD	Sehorn clay	High	0.06-0.2	Moderate to slight	High
SmD	Sehorn-Balcom complex	Moderate	0.2-0.63	Slight to moderate	Moderate
Sv	Sycamore complex	Moderate	0.06-0.63	Slight to none	High
S1D	Sehorn cobbly clay	High	0.06-0.2	Slight to none	High
TaB	Tehama loam	Moderate	0.06-2.0	Slight to none	Low to high
Wn	Willows clay, marly variant saline-alkali	Moderate to high	0.06-0.63	Slight to none	High
Yb	Yolo silty clay loam	Moderate	0.2-2.0	Slight to none	Moderate
Za	Zamora loam	Moderate	0.63-2.0	Slight to none	Low to moderate

Source: U.S. Department of Agriculture, Soil Conservation Service, 1972, Soil Survey of Yolo County, California.

[1] Shrink-swell potential is the extent to which the soil shrinks as it dries or swells when wet. A high shrink-swell rating indicates a hazard to structures.

[2] Permeability is the ability of a soil to transmit air or water.

[3] Erosion hazard is the propensity of a soil to erode when tilled or exposed.

[4] Corrosivity pertains to the potential for soil-induced chemical action that dissolves or weakens uncoated steel.

resources includes the classification of Mineral Resource Zones (MRZs) on the basis of existing geologic data. Identified zones, where sufficient data indicate the likelihood for occurrence of significant aggregate deposits is high, are designated MRZ-2. If land uses within MRZ-2 zones are compatible with aggregate mining, the zones are classified as "sectors." Under the State mineral lands classification system, the available tonnage of aggregate resources within sectors is then estimated.

The planning area is delineated on the basis of the boundaries of the MRZs recognized in the CDMG classification report (Dupras, 1988), exclusive of the area defined by the in-channel boundary. The area covered by all of the Mineral Resource Zone boundaries is approximately 28,130 acres. Areas for which existing evidence does not indicate that significant aggregate deposits are present, MRZ-1, comprise approximately five percent of the planning area. Areas that were determined by CDMG to contain mineral resources but the significance of the deposits could not be determined (MRZ-3) comprise 29 percent of the planning area. The MRZ-1 and MRZ-3 areas are located along the perimeter of the planning area (Figure 3.2-3).

Approximately 66 percent of the planning area is designated as MRZ-2, areas in which adequate information indicates that significant aggregate deposits are available. The MRZ-2 areas are located in the central portion of the planning area and were estimated in 1982 by CDMG to contain approximately 838 million tons of PCC-grade aggregate resources at the time of the evaluation (Dupras, 1988). Of this total, 111 million tons of aggregate were estimated to be located under the Cache Creek channel at elevations below the current in-channel mining depth limit imposed by Yolo County. Based on aggregate production records, an additional 31 million tons of aggregate have been excavated from 1982 to 1995.

The CDMG report classifies most of the MRZ-2 areas within the project site as resource sectors that meet or exceed the State thresholds for designation of resources as of regional or statewide significance. The planning area is divided into four sectors (A through D) on the basis of location; each sector is divided into subsectors. The sectors of the MRZ-2 areas of the lower Cache Creek basin have not been formally designated by the State Mining and Geology Board (SMGB).

Cache Creek Morphology and Processes

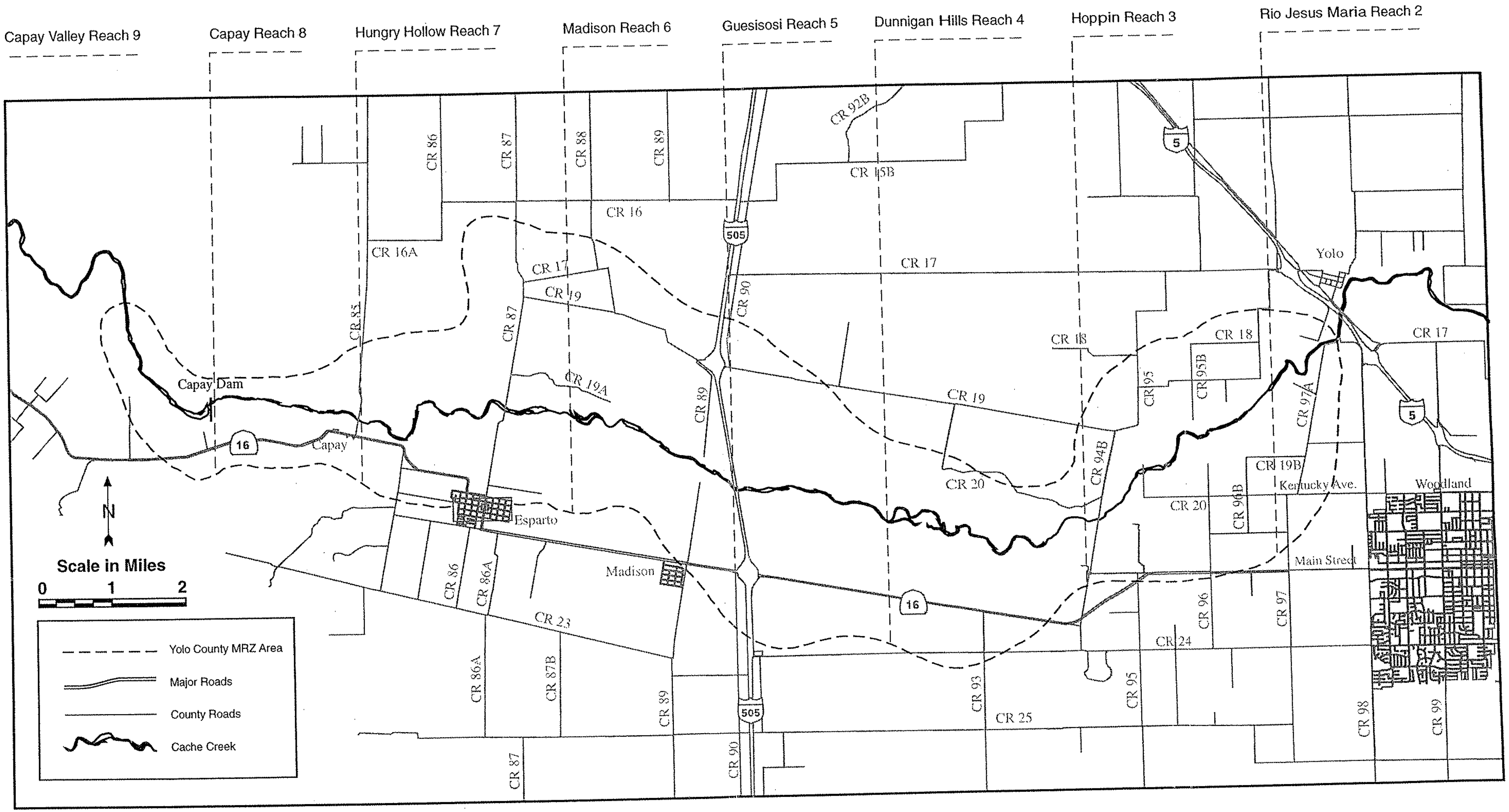
Stream Morphology

The shape, or morphology, of a stream channel is a function of the characteristics of the flow (volume and velocity) carried by the stream and the composition of sediments forming its banks and stream bed. Cache Creek, its channel and adjacent floodplain, is the central geomorphic feature of the planning area. The creek and its principal tributaries have a drainage area of over 1,100 square miles, extending from its headwaters at Clear Lake to its terminus at the Yolo By-Pass. Major physiographic provinces have developed along the course of the creek, which are functions of topography, geology, hydrology, and vegetation. The upper portion of the watershed is characterized by relatively flat valleys. Eastward of this region, the creek becomes very steep and incised, flowing through mountainous terrain. Within this province, high sediment yields are produced that are transported downstream by the creek. The creek then emerges into the Capay Valley, a broader alluvial valley. Although sediment is transported fairly efficiently through this province, some deposition and temporary storage of sediment occurs. Near the town of Capay, the creek turns eastwardly and flows into the Sacramento Valley. Emerging from the mountains, the gradient (slope) of the creek decreases dramatically and significant deposition occurs. This depositional province is the setting of the planning area.

Within the planning area, Cache Creek is a broad alluvial stream. The morphology of the creek is variable and could be characterized as a low-gradient, entrenched meandering stream. The slope of the channel (0.13 to 0.23 percent) is low for most natural meandering rivers. The low gradient could be related to both the tectonic setting of the creek and influences imposed by human activity. In its natural condition, the creek flowed out onto a large, gently sloping alluvial fan. The fan was formed in a predominantly depositional setting. In this condition, the channel was probably a shallow, wide system of channels characteristic of a braided stream. However, the channel of Cache Creek migrated across the fan, occupying numerous channels. It was the formation and abandonment of these numerous "distributary channels," which built the alluvial fan. Under current conditions, the channel has incised into the fan and has occupied the same general position on the fan throughout historical times. Evidence of former channel positions, which have been abandoned by the stream are expressed by coarse sand and gravel deposits found throughout the planning area. Surface expression of the abandoned channels have largely been obliterated by agricultural grading. Although the channel may have migrated significantly, the positions of emergence of the creek onto the valley at Capay and the well-established channel through the Dunnigan Hills constrain the creek's location at these points.

Nine geomorphic subreaches from Capay Valley to the Settling Basin have been identified along Cache Creek within the planning area (NHC, 1995). Each subreach was identified on the basis of distinctive differences in channel morphology when compared to areas upstream or downstream. The subreaches identified from the western (upstream) boundary of the planning area to the eastern (downstream) boundary include: Subreach 8 - Capay; Subreach 7 - Hungry Hollow (Capay Bridge to one mile downstream of Esparto Bridge); Subreach 6 - Madison; Subreach 5 - Guesisosi; Subreach 4 - Dunnigan Hills; Subreach 3 - Hoppin; and Subreach 2 - Rio Jesus Maria. The location of each subreach is shown on Figure 4.3-4.

The morphology of the Cache Creek channel within the planning area has been significantly influenced by human activities. The sediment supply has been significantly reduced by the installation of the Indian Valley and Capay dams located upstream of the project site. The width of active channel has been controlled and generally reduced through influences of agricultural land reclamation, construction of bridges across the creek and irrigation canals along the creek. Significant aggregate mining, in operation since the



SOURCE: NHC, 1995

Figure 4.3-4 Geomorphic Reaches of Cache Creek

beginning of the 20th century, in the active channel has presented another significant control on the position of the channel. The Technical Studies (NHC, 1995) document that overall the channel width has been dramatically reduced over the period 1937 to present, with the width of some reaches of the creek reduced by 85 percent. Excavation of aggregate from the channel in excess of natural replenishment has also caused localized oversteepening of the channel. Reduction of the channel width has resulted in increased flow velocities. Localized restrictions of the channel, particularly those associated with bridges, have further increased flow velocities at these locations. The documented response of the creek to these changes has been degradation of the channel bed and straightening of the channel.

Flows

The climate and topographic conditions of the Cache Creek drainage basin present conditions that produce widely variable annual and seasonal fluctuations in flows within the creek. Under natural and current conditions, winter (rainy season) flows in the creek significantly exceed summer flows but have a wide range of annual peak flow values. Winter and spring rainfall can produce rapid changes in stream flow (discharge) over short periods of time. This potential for variability characterizes the flows in the creek as "flashy" or "episodic." Annual peak flows have ranged from near zero during drought years such as 1976 and 1977 to over 40,000 cubic feet per second (cfs) in 1958 and 1995 (NHC, 1995).

Sediment Load/Budget

The current estimated total (suspended and bed load) annual sediment load for Cache Creek near western margin of the planning area is 927,600 tons per year (NHC, 1995). The major portion of the sediment carried by the creek is fine-grained sediment transported as suspended load. Approximately 23 percent (210,100 tons per year) of the sediment load is sand and gravel transported as bed load. The annual sediment delivered to the planning area is greatly reduced in comparison to the sediment loads that were carried to the area prior to the installation of the dams upstream of the planning area.

Channel Stability

Substantial incision, or stream bed lowering, has been documented during historic times along Cache Creek. During the period from 1959 to 1980, the stream bed was lowered by an average of 15 feet (Collins and Dunne, 1990). The incision has resulted in increased cross-sectional area of the stream and a corresponding increase in floodwater storage. Collins and Dunne (1990) have suggested that the potential for overbank flooding has been eliminated due to the increased flood conveyance capacity. Hydraulic analyses prepared for the proposed projects within the planning area (Cunningham Engineering, 1993) indicate that the 100-year flood flows would be contained within the channel of Cache Creek throughout most of the planning area.

Streams are natural systems in dynamic equilibrium that adjust continually to changes in sediment supply, volume or velocity of flow, and irregularities within the channel. Channel incision on Cache Creek has been directly linked to the effects of gravel extraction caused by historic in-stream mining (summarized by Collins and Dunne, 1990). However, incision can also be related to reduced sediment supply in Cache Creek caused by interception of sediment by dammed reservoirs upstream of the subject reach. Although the dams also reduce the peak of some flood flows, the Creek is clearly capable of transporting sand and gravel bed load. If sediment supply is not provided to a stream capable of transporting these materials, the stream will erode its banks or bed.

Regulatory Setting

SMARA and Related Regulations

The California Surface Mining and Reclamation Act (SMARA) was enacted in 1975 to provide a means of identifying potential mineral resources throughout the State and to provide for reclamation of mined lands. The stated intent (Section 2712) of SMARA is to ensure that:

a) Adverse environmental effects are prevented or minimized and that all mined lands are reclaimed to a usable condition which is readily adaptable for alternative land uses;

b) The production and conservation of minerals are encouraged, while giving consideration to recreation, watershed, wildlife, range and forage, and aesthetic enjoyment;

c) Residual hazards to the public health and safety are eliminated.

The classification of an area as a source of significant mineral deposits requires lead agencies to establish resource management policies that will emphasize the conservation and development of identified mineral deposits (Section 2762). SMARA also requires (Section 2774) the development and adoption of ordinances in accordance with the policies of SMARA that establish procedures for the review and approval of reclamation plans for permitted mining areas. Yolo County has prepared the OCMP and its implementing ordinances to replace existing mining and reclamation ordinances and establish controls on mining that are consistent with the most recent amendments to SMARA and the State Mining an Geology Board Reclamation Regulations. The Impacts and Mitigation Measures section of this DEIR will evaluate the consistency of the OCMP and its implementing ordinances with SMARA.

As required by SMARA (Section 2755), the State Mining and Geology Board (SMGB) regulations for surface mining and reclamation practice and performance standards for reclamation (CCR Title 14, Chapter 8, Subchapter 1) are applicable to the off-channel mining operations proposed under this project. The regulations (Sec. 3502) present objectives and required elements for reclamation plans. Required elements of the reclamation plan for addressing the environmental setting, public health and safety, steepness of excavated and filled slopes, and backfilling and grading of disturbed areas have been included in the OCMP. Public health and safety issues are further discussed in Section 4.12 of this DEIR. The regulations also include minimum acceptable practices (Sec. 3503) for erosion control, backfilling and grading, and topsoil salvage, maintenance, and redistribution.

Yolo County General Plan

Mining and reclamation activities are addressed in several goals and policies contained in the Yolo County General Plan. The general goals that relate to aggregate mining include:

- Provide for industrial growth in the County to provide employment, services, and tax base while minimizing hazards and nuisances and while conserving resources and agricultural lands;
- Provide for seismic safety;
- Control erosion and practice soil management;
- Conserve natural resources.

The General Plan also includes the following safety (S) and conservation (CON) policies that relate to aggregate mining:

S 1	Yolo County shall regulate, educate, and cooperate to reduce death and injuries or damage to property and to minimize the economic and social dislocation resulting from ... geologic hazards.
CON 2	Yolo County shall foster conservation of its resources and avoid natural hazards by planning, encouraging, and regulating the development and use of these resources.
CON 3	Plans, projects, and programs shall treat land as a resource rather than as a commodity.
CON 9	Yolo County shall ensure the protection, maintenance, and wise use of the State's natural resources, especially scarce resources and those that require special control and management.
CON 10	Yolo County shall plan, encourage, and regulate public and private agencies to prevent wasteful exploitation, destruction and/or neglect of the State's resources.
CON 34	Yolo County shall adopt a Mining Ordinance to implement these policies as they apply to mineral resources, including sand and gravel.

The proposed project is generally in compliance with each of these goals of the General Plan. The inconsistency or incompatibility of specific items related to geology and soils in the OCMP with the General Plan is addressed below.

IMPACTS AND MITIGATION MEASURES

Standards of Significance

The project would have a significant effect on geology and soils if it would result in:

- Exposure of people or property to geologic hazards, including but not limited to:
  - Fault rupture on active faults;
  - Seismic shaking (accelerations greater than 0.1g);
  - Seismically-induced ground failure, including liquefaction;
  - Landslides or mudflows (includes excavated slopes);
  - Erosion, changes in topography or unstable soil conditions from excavation, grading, or fill;
  - Subsidence of the land; or
  - Expansive soils.
- Destruction, covering, or modification of unique geologic or physical features.
- Result in the loss of availability of a known mineral resource that would be of future value to the region.

Impact 4.3-1
Potential for Damage from Seismic Shaking

In general, the low relief topography and alluvial sediments within the planning area are relatively stable and do not present hazards associated with failure under static (aseismic) conditions. However, proximity of the planning area to the Coast Range-Sierran Block Boundary Zone suggests that expected earthquakes on faults within the zone could cause strong ground shaking within the planning site. Seismic shaking at the expected levels can cause failure of unstable slopes or liquefaction. The potential for slope failure during seismic shaking is addressed in Impact 4.3-2.

Liquefaction is a condition caused by seismic shaking that results in the loss of strength of saturated, loose, unconsolidated granular sediments. Liquefied sediments can flow to a free face (e.g., stream channel cutbank or submerged mining pit slope) resulting in lateral spreading or settlement of the ground surface. In general, Quaternary alluvial sediments similar to those that underlie most of the planning area are sufficiently dense and well-graded[6] to resist liquefaction (Kleinfelder, 1995a, 1995b). Although groundwater occurs at relative shallow depths (10 to 35 feet below ground surface) throughout most of the

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[6] A well-graded sediment has a well-mixed, wide range of sediment sizes including fine- and coarse-grained sediments.

planning area, the sand and gravel aquifer underlying the area is generally unconfined and high pore water pressures required for liquefaction are unlikely to develop.

Some of the younger, less dense sediments that occur in the planning area may include saturated, loose sediment that could be subject to liquefaction. Existing or future aggregate mining pits may be partially backfilled with the processing fines[7] produced by the washing of aggregate at the processing plants. These materials, when loose and saturated, have a high potential for liquefaction. The method of placement of these sediments (natural settlement out of processing water returned to the mining pits) beneath the groundwater table indicates that these sediments would be loose and saturated during and after reclamation. Overburden materials placed as fill in pits below the groundwater level may also be susceptible to liquefaction.

Liquefaction could result in settlement of the ground surface that could affect improvements constructed in areas underlain by liquefiable sediments. The potential effects of settlement could include damage to buildings or disruption of drainage. The backfilled material in mining pits could also be subject to settlement or consolidation under static (non-seismic) conditions if loads (e.g., buildings) are placed on these fills.

Draft OCMP and Implementing Ordinances

The OCMP would allow the excavation and reclamation of off-channel mining pits within the planning area. The OCMP does not limit the types of post-reclamation uses for formerly mined areas. Five long-term mining applications have been submitted to Yolo County and are currently under environmental review; a sixth mining application is reasonably foreseeable in the next five years. Reclamation plans submitted with the applications indicate that of the 2,211 acres proposed to be mined, 988 acres would be reclaimed to agricultural uses. This reclamation would require that the mined areas are backfilled. Mining pits are typically backfilled with processing fines and overburden. The placement of the fill is not usually controlled by soil engineering specifications (i.e., the fills are non-engineered).

The drainage of reclaimed mining pits backfilled with non-engineered fill could be affected by settlement of the fills. Settlement could occur as the result of compaction or consolidation of the sediment over time. Compaction could also result from liquefaction of some of the sediments within the alluvium during strong seismic shaking. Structures constructed on the fills could be damaged by effects of settlement. The following OCMP Performance Standard addresses the potential of land surface settlement of mined areas reclaimed to agricultural use:

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[7] Processing fines are the clay, silt, and fine sand particles washed from the aggregate during processing.

PS. 5.5-3: The operator shall resurvey any areas reclaimed to agricultural usage after the first two (2) crop seasons have been completed. Any areas where settling has occurred shall be re-leveled to the field grade specified in the approved reclamation plan.

This standard provides mitigation for the potential for settlement of reclaimed agricultural fields. The standard is consistent with the intent of Section 3704 of the SMGB Reclamation Regulations to provide monitoring of the performance of lands backfilled for resource conservation purposes. However, the construction of improvements sensitive to settlement in backfilled reclaimed areas could be damaged by settlement. The standard does not address inspection of the fills following potential earthquakes which could cause strong ground shaking within the planning area. Reclamation plans for mining projects should be required to include a source of backfill material for releveling fill areas which have settled.

Alternative 1a: No Project (Existing Conditions) and Alternative 1b: No Project (Existing Permits and Regulatory Condition)

Under these alternatives, current off-channel aggregate mining would be allowed to continue. Agricultural land use would continue throughout most of the planning area. The current in-channel mining conducted along Cache Creek would occur outside the planning area. The current off-channel mining would be performed under the requirements of SMARA, the existing "interim" Yolo County Mining and Reclamation Ordinances and the conditions for mining permits. Specific requirements of these regulations address the stability of reclaimed lands with respect to the intended post-reclamation use. However, the existing requirements do not address potential changes in post-reclamation use that could be more sensitive to unstable fill. This is considered to be a significant impact.

Alternative 2: No Mining (Alternative Site) and Alternative 3: Plant Operation Only (Importation)

No mining would occur in the planning area under these alternatives. The potential impacts associated with unstable fills in reclaimed mining pits would not occur within the planning area. Mining and reclamation required to produce aggregate materials for importation to aggregate processing plants within the planning area could result in the placement of non-engineered fills outside the planning area. Although, the State Mining and Geology Board Reclamation requirements present minimum standards for backfilling, it is possible that settlement of fills could result in damage to land or structures during the post-reclamation period. This is a significant impact.

Alternative 4: Shallow Mining (Alternative Method/Reclamation)

This alternative would limit the depth of mining such that mining pits would not extend to depths below the seasonal high groundwater level; no wet pit mining would occur. The shallow mining could, however, require backfilling of mined areas to raise the reclamation surface to ten feet above seasonal high groundwater level. Mining pits would likely be filled with non-engineered fill, including processing fines and overburden sediments. These fills could be placed below the seasonal groundwater table if sufficient volumes of backfill were available. The potential for settlement of the fills would be a potential significant impact on future drainage or stability of structures.

Alternative 5a: Decreased Mining (Restricted Allocation)

This alternative would restrict the rate of aggregate production but could result in the excavation of off-channel mining pits. The mining methodologies could include deep, wet pit mining. Under this alternative, all potential impacts related to potential unstable fills could occur.

Alternative 5b: Decreased Mining (Shorter Mining Period)

Under this alternative, individual off-channel mining permits for mining in the planning area would be limited to 15- to 25-year permits. Under these conditions, it would be expected that mining of aggregate in the planning area would include deep pit mining. The potential impacts related to unstable fills within reclaimed pits could occur.

Alternative 6: Agricultural Reclamation (with Mining Operations as Proposed)

This alternative would require that a minimum of 80 percent of the mining areas be reclaimed for agricultural use. The alternative does not limit mining methodologies and implies that deep mining would be expected. For mining areas that extend to depths below seasonal high groundwater, additional fill materials would be necessary to construct agricultural surfaces that are sufficiently elevated above the groundwater table. The potential impacts of unstable fills on structures would be limited by the requirement to convert the majority of the mining areas to agricultural use.

Mitigation Measure 4.3-1a (OCMP, A-4, A-5a, A-5b, A-6)

The following performance standards shall be added to the OCMP and its implementing ordinances and existing ordinances:

Performance Standard 2.5-25: Improvements, including the construction of buildings, roadways or other public facilities proposed for construction in reclaimed mining pits shall require a geotechnical investigation of the stability of fills conducted by a qualified and licensed geotechnical engineer. A report on the results and recommendation of the investigation shall be submitted to the Yolo County Community Development Agency prior to the issuance of building permits.

Performance Standard 2.5-26: Backfilled mining areas and slopes shall be inspected by the landowner following strong seismic shaking events. Observable damage shall be reported to the Yolo County Community Development Agency. If, upon inspection of the reported damage, the YCCDA determines that the damage requires repair to meet the intended use of the reclaimed land, the landowner shall perform the required repairs.

Performance Standard 2.5-27: The cost of implementing recommendations for repair of reclaimed land caused during earthquakes or other natural events shall be met through application of contingency costs provided for by the project's financial assurances as required by SMARA.

Implementation of the this mitigation measure would reduce this impact to a less-than-significant level for the OCMP and Alternatives 4, 5a, 5b, and 6).

Mitigation Measure 4.3-1b (A-1a, A-1b, A-2, A-3)

Existing mining ordinances shall require a geotechnical investigation of the stability of fills conducted by a qualified and licensed geotechnical engineer for improvements proposed for construction in reclaimed mining pits, including the construction of buildings, roadways, or other public facilities. A report on the results and recommendation of the investigation shall be submitted to the Yolo County Community Development Agency (or other similar authority in areas outside Yolo County) prior to the issuance of building permits.

Implementation of the this mitigation measure would reduce this impact to a less-than-significant level for Alternatives 1a, 1b, 2, and 3.

Impact 4.3-2
Potential Impacts Related to Slope Stability, Erosion, and Sedimentation

The lower Cache Creek basin contains extensive sand and gravel aggregate resources. Mining of these resources is expected to continue in response to regional demand for high quality aggregate materials. Off-channel mining operations would create cut slopes in the existing topography as aggregate is mined and a depression is created. The constructed slopes could be subject to slope failure or increased erosion. The identified off-channel aggregate resources in the lower Cache Creek basin are located on relatively flat or gently sloping alluvial terrace surface. The underlying geologic materials are recently deposited alluvial sediments that are unconsolidated to poorly consolidated. Slopes excavated within these types of materials can be prone to slope failure if inappropriately designed and constructed.

Under existing conditions, the erosion hazard for the surface soils of the lower Cache Creek basin is slight to negligible. However, the excavation of pits would significantly increase the slope of the land surface. The potential for erosion is raised with increased slope angle as storm water runoff velocity is correspondingly increased. Exposed soils and sediments can be subject to erosion if not protected with vegetative cover. If surface runoff from outside mining areas is directed into excavations, the incision of runoff drainage channels could occur. The incision could result in gullying or oversteepened channel banks that could be unstable and prone to slope failure.

The erosion of soil at mining areas and adjacent lands could result in the transportation of the sediment away from affected areas. Deposition of eroded soil could occur in places (e.g., in the bottom of deep lakes formed in mining pits) where retrieval and reuse of these soils would not be possible. Sediment generated by erosion could adversely affect water quality by raising turbidity, or cause drainage problems that could result in localized flooding.

Draft OCMP and Implementing Ordinances

The OCMP would allow for the extraction of aggregate resources at off-channel locations, increasing the possibility of excavation on the alluvial terraces along Cache Creek. The excavation of the mining pits would expose soil to increased erosion hazards. The potential for erosion would be greatest during the rainy season while mining occurs; the erosion potential would be relatively reduced following vegetation of slopes during and after reclamation.

The OCMP includes the following policies that are intended to reduce the potential impacts of slope instability, erosion, and sedimentation during the mining and reclamation periods:

Obj. 2.3-3: Provide standards and procedures for regulating surface mining operations so that hazards are eliminated or minimized and potential adverse environmental effects are reduced or prevented.

With regard to the potential impact associated with slope instability, erosion, and sedimentation, this objective is supported by the following Performance Standards:

PS. 2.5-4: During operations, a series of benches may be excavated in a slope. The maximum vertical height of the benches shall not exceed ten (10) feet, and all banks shall not exceed 1:2 (horizontal to vertical). Slopes shall not exceed 1:1 (horizontal to vertical) below the summer low water level of exposed groundwater in water filled excavations.

This standard does not meet the minimum design guidelines for slope construction contained in the California Code of Regulations (Title 8, Article 6). These regulations apply to the protection of people working within excavated areas. The topsoil and overburden sediments typical of the alluvial deposits in the Mineral Resource Zones within the lower Cache Creek basin range in textural class from silty clay to gravelly sandy loam and would be classified as Type B soil under the Article. The sand and gravel aggregate resources would be classified as Type C soils. The regulations under the Article set maximum allowable slopes for Type B soil at 1:1 and for Type C soil at 1.5:1. Benching of slopes in Type B soils is allowed only in "cohesive soil" (i.e., soil with high clay content and cohesive strength). The maximum allowable height of the bench is four feet. The requirements of the CCR would presumably only apply to soil and sediments above the groundwater table because people would not be exposed to slope failure hazards below water level.

The provisions of Performance Standard 2.5-4 allow for the construction of slopes that could be unstable during and following excavation. Therefore, Performance Standard 2.5-4 should be eliminated from the OCMP or modified to comply with State excavation standards.

PS. 2.5-16: Except where benches are used, all banks above groundwater level shall be sloped no steeper than 2:1 (horizontal:vertical). Proposed steeper slopes shall be evaluated by a slope stability study, prepared by a qualified engineer. Slopes below the groundwater level shall be no steeper than 1:1 (horizontal:vertical).

Performance Standard 2.5-16 is generally consistent with the requirements of SMARA for maximum mining slopes. The maximum cut slope for final pit slope is required by SMARA (Section 3704(f)) to have a minimum slope stability factor of safety that is suitable for the proposed end use and conform with the surrounding topography and/or approved end use. Slope stability analysis performed on proposed mining slopes within the Cache Creek basin indicate that slopes of 2:1 are generally appropriate for the typical profile of surface materials found in the basin. Given the availability of slope stability analyses performed at locations that can be considered representative of the subsurface conditions within the basin, this maximum slope gradient is supportable. The performance standard does not, however, specify the acceptable factor of safety for the various end uses allowed by the OCMP. However, the acceptable factor of safety is addressed in Performance Standard 2.5-18. The standard also implies that steeper slopes may be allowed if slopes are analyzed by a slope stability analysis. The long-term stability of steeper slopes, particularly those excavated in the fine-grained overburden materials is questionable. The steepness of slopes with regard to public health and safety (falling and drowning) is discussed in the Hazards section of this EIR.

PS. 2.5-17: Upon the completion of operations, grading and revegetation shall minimize erosion and convey surface runoff to natural outlets or interior basins. The condition of the land shall allow sufficient drainage to prevent water pockets or undue erosion. Natural and storm water drainage shall be designed so as to prevent flooding on surrounding properties and County rights-of-way.

Silt basins which will store water during periods of surface runoff shall be equipped with sediment control and removal facilities and protected spillways designed to minimize erosion when such basins have an outlet to lower ground and/or Cache Creek.

This standard presents goals of minimizing erosion, efficient conveyance of storm water runoff, and appropriate design of silt basins. Achieving these goals would reduce the potential impacts of erosion and sedimentation on receiving waters such as Cache Creek. The standard does not, however, present specific design criteria or design options for meeting the standard. The standard requires that final grading promote conveyance of runoff to natural outlets or interior basins. The standard does not specifically exclude mining pits as interior basins. Runoff, with the exception of sheetflow generated on the slopes surrounding mining areas, should not be directed into active mining pits or reclaimed lakes. The standard does not specifically address the potential for erosion during the mining period. Significant erosion could occur during mining, particularly on slopes with exposed soil. Erosion of topsoil and overburden sediment and transportation into the mining pits could reduce the amount of soil materials available to meet reclamation needs. The standard should be modified to more specifically address erosion hazard mitigation.

PS. 2.5-18: All final reclaimed slopes shall have a minimum safety factor equal to or greater than the critical gradient as determined by an engineering analysis of the slope stability. Final slopes less than five (5) feet below groundwater shall be designed in accordance with the reclaimed use. Reclaimed wet pit slopes located five (5) feet or more below groundwater level shall not exceed 1:1 (horizontal:vertical), in order to minimize the effects of sedimentation and biological clogging on groundwater flow and to prevent stagnation.

The standard indicates that the minimum factor of safety for final reclaimed slopes shall be determined by engineering analysis but does not specify the slope stability analysis required. The standard also indicates that slopes at elevations that could be affected by groundwater fluctuations should be designed in accordance with the reclaimed uses of these areas. The standard should be modified to include specific design guidelines for maximum slopes that address the subsurface conditions (i.e., soil type and groundwater conditions) and alternative reclaimed uses.

PS. 2.5-21: The grading of final slopes, the replacement soil, and associated erosion control measures shall take place prior to November 1 in areas where mining has been completed. To minimize erosion, all slopes above the groundwater level shall be seeded with a drought-tolerant mix of native and non-native grass species, as soon as is practical after grading and prior to November 1. The grass seed mix shall be weed-free.

This standard partially mitigates the potential erosion of soil exposed during off-channel mining and reclamation activities. The standard provides an annual schedule for grading of final slopes, replacement of soil, and associated erosion control measure. The standard does not address the potential for erosion of non-reclaimed slopes or define a relative schedule for reclamation mining pit slopes. This standard should be supplemented with a standard that minimizes the amount of unreclaimed slopes exposed to rainy season conditions, which promote erosion, and that addresses the control of erosion of active mining slopes.

PS. 2.5-22: Permanent piles of mine waste and/or overburden shall be stabilized and contoured to conform visually and functionally with the surrounding topography. Berms and swales shall generally parallel and angle downstream towards the creek, instead of perpendicular to it.

PS. 5.5-2: Topsoil stockpiles shall not exceed forty (40) feet in height, with slopes no steeper than 2:1 (horizontal:vertical). Stockpiles shall be seeded with a vegetative cover to prevent erosion and leaching. The use of topsoil for purposes other than reclamation shall not be allowed without the prior approval of the Community Development Director.

Performance Standard 2.5-22 does not provide specific guidelines for control of erosion of soil and sediment stockpiles. However, the OCMP includes Performance Standard 5.5-2, which limits the maximum height of stockpiles, specifies a maximum slope angle for their side slopes, and requires vegetative cover for the piles. These standards provide appropriate mitigation of the potential for erosion of the sediment stockpiles.

The provision of Performance Standard 2.5-22 to orient berms and swales in a particular direction would likely conflict with Performance Standard 3.5-3, which requires berms and swales to prevent storm water runoff from entering mining pits. The orientation of the berms and swales for this purpose would be dictated by the orientation of the pits and the topography of surrounding lands. Performance Standard 2.5-22 shall be eliminated from the OCMP as the provisions of this standard are covered by other standards.

Alternative 1a: No Project (Existing Conditions)

Under this alternative, current off-channel aggregate mining would be allowed to continue. Agricultural land use would continue throughout most of the planning area. The current off-channel mining would be performed under the requirements of SMARA, Yolo County Mining and Reclamation Ordinances and the conditions for mining permits. The requirements of these regulations address control of erosion and slope stability impacts. SMARA includes the SMGB Reclamation Regulations, which present specific reclamation standards that specify erosion and slope stabilization requirements for reclamation. Neither SMARA nor the County Mining and Reclamation Ordinances present specific controls for erosion and slope stability for the mining period. However, erosion and slope stability controls provided in the conditions of approval for the currently permitted off-channel mining projects would mitigate the impacts related to slope stability, erosion, and sedimentation. Erosion related to in-channel mining operations is also controlled by existing mining and reclamation requirements. The existing controls on erosion during mining would reduce the impact to a less-than-significant level.

Alternative 1b: No Project (Existing Permits and Regulatory Condition)

The controls on erosion and slope stability described for Alternative 1a would apply to mining projects under this alternative and would mitigate impacts to a less-than-significant level.

Alternative 2: No Mining (Alternative Site)

Under this alternative, no aggregate mining would be performed in the planning area. Therefore, impacts related to erosion and slope stability caused by mining and reclamation activities would not occur. Changes in topography that could occur under this alternative could result in erosion and slope stability problems caused by agricultural operation or development projects. The potential effects of development projects would be addressed by the applicable local development review process and the statewide General Construction Activity Storm Water Permit. Under this alternative, the slope stability, erosion, and sedimentation impacts within the planning area would be less-than-significant. However, aggregate mining in areas away from the project could be significant depending on the location mining and methodologies for mining and reclamation. All large scale earthworks projects, such as surface mining operations, typically produce potential slope stability and erosion impacts.

Alternative 3: Plant Operation Only (Importation)

No mining would occur in the planning area under this alternative. The impacts related to erosion and sedimentation potential caused during the mining and reclamation of mining pits would not occur within the planning area. The importation of aggregate materials to maintain operation of aggregate processing plants implies mining and reclamation of aggregate resources in an area outside the planning area. Aggregate mining in areas away from the project could be significant depending on the location of the mining and methodologies for mining and reclamation. All large scale earthworks projects, such as surface mining operations, typically produce potential slope stability and erosion impacts.

Alternative 4: Shallow Mining (Alternative Method/Reclamation)

This alternative would limit the depth of mining such that mining pits would not extend to depths below the seasonal high groundwater level; no wet pit mining would occur. The shallow mining would, however, create excavation that would disrupt the topography and would create slopes that could be potentially subject to unstable conditions and erosion. Slope stability could be maintained by limiting the steepness of the mining and reclamation slopes and by providing protection against erosion. Relative to open pits, the potential for water quality impacts related to erosion would not occur as sediment washed from pit side slopes would be transported to and deposited in a dry environment instead of a surface water body.

Alternative 5a: Decreased Mining (Restricted Allocation)

This alternative would restrict the rate of aggregate production but would result in the excavation of off-channel mining pits. The mining methodologies would include deep, wet pit mining. Under this alternative, all potential impacts related to erosion and slope stability related to the excavation of pits could occur.

Alternative 5b: Decreased Mining (Shorter Mining Period)

Under this alternative, individual off-channel mining permits for mining in the planning area would be limited to 15- to 25-year permits. Under these conditions, it would be expected that mining of aggregate in the planning area would include deep pit mining. All potential impacts related to erosion and slope stability related to the excavation of pits could occur.

Alternative 6: Agricultural Reclamation (with Mining Operations as Proposed)

This alternative would require that a minimum of 80 percent of the mining areas be reclaimed for agricultural use. The alternative does not limit mining methodologies and implies that deep mining would be expected. For mining areas that extend to depths below seasonal high groundwater, additional fill materials would be necessary to construct agricultural surfaces that are sufficiently elevated above the groundwater table. The excavation of fill materials would expand the area disturbed for mining and reclamation activities. Erosion and slope stability impacts under this alternative would be similar to those related to pit excavation. If all other factors affecting erosion are held constant, a proportional increase in erosion would be expected with the expansion of disturbed areas.

Mitigation Measure 4.3-2a (OCMP, A-4, A-5a, A-5b, A-6)

To address the potential impacts of slope instability, erosion, sedimentation, and public safety during aggregate mining, mined land reclamation, and post-reclamation use of mined lands, the following performance standards of the OCMP shall be modified as follows:

Performance Standard 2.5-4: During mining operations, a series of benches may be excavated in a slope. The vertical height and slope of the benches shall not exceed ~~ten (10) feet, and all banks shall not exceed 1:2 (horizontal to vertical)~~ maximum standards for the specific soil types presented in California Code of Regulations, Title 8, Article 6. In general, vertical cutslopes between benches shall not exceed four feet in height in topsoil and overburden sediments. Benching shall be allowed in cohesive soil (clay, sandy or silty clay, clayey silt) only. Slopes above the elevation of groundwater (determined at the time of excavation by the level of exposed water in the excavation) that exceed the maximum vertical height shall be excavated and maintained at slopes of not greater than 2:1. Slopes located five (5) feet or less below the average summer low groundwater level shall not be steeper than 2:1. Slopes located more than five (5) feet below the average summer low groundwater level shall not ~~exceed~~ be steeper than 1:1 (horizontal to vertical). ~~below the summer low water level of exposed groundwater in water-filled excavations.~~

Performance Standard 2.5-16: Except where benches are used, all banks above groundwater level shall be sloped no steeper than 2:1 (horizontal:vertical). Proposed steeper slopes shall be evaluated by a slope stability study, prepared by a qualified engineer. Slopes below the groundwater level shall be no steeper than 1:1 (horizontal:vertical). Slopes located five feet or less below the summer low groundwater level shall not be steeper than 2:1.

Performance Standard 2.5-17: Upon the completion of operations, grading and revegetation shall minimize erosion and convey surface runoff to natural outlets or interior basins. The condition of the land shall allow sufficient drainage to prevent water pockets or undue erosion. Natural and storm water drainage shall be designed so as to prevent flooding on surrounding properties and County rights-of-way.

Storm water runoff from mining areas shall be conveyed to lowered areas (detention basins) to provide detention of runoff generated during a 20-year, one-hour storm event. All drainage conveyance channels or pipes (including spillways for detention areas) shall be designed to ensure positive drainage and minimize erosion. The drainage conveyance system and storm water detention areas shall be designed and maintained in accordance with Best Management Practices for the reduction of pollutants associated with runoff from mined areas. The design and maintenance procedures shall be documented in the Storm Water Pollution Prevention Plan required for mining operations. The drainage system shall be inspected annually to ensure that the drainage system is functioning effectively and that adverse erosion and sedimentation are not occurring. The annual inspection shall be documented in the Annual Mining and Reclamation Report.

Performance Standard 2.5-18: All final reclaimed slopes shall have a minimum safety factor equal to or greater than the critical gradient as determined by an engineering analysis of the slope stability. Final slopes less than five (5) feet below the average summer low groundwater level be *designed in accordance with the reclaimed use and shall not be steeper than 2:1. Reclaimed wet pit slopes located five (5) feet or more below the average summer low groundwater level shall not ~~exceed~~ be steeper than 1:1 (horizontal:vertical), in order to minimize the effects of sedimentation and biological clogging on groundwater flow and to prevent stagnation and to protect the public health.*

The maximum slope angle for all final reclaimed slopes shall be determined by slope stability analysis performed by licensed and qualified civil or geotechnical engineer and submitted with any mining and reclamation application for review by the Yolo County Community Development Agency (YCCDA). The slope stability analysis shall conform with industry standard methodologies rotational slope failures under static and pseudostatic (seismic) conditions. The minimum factor of safety for all design reclamation slopes located adjacent to levees or below existing structures shall not be less than 1.5 for static and 1.1 for pseudostatic (seismic) conditions. Other reclamation slopes shall meet a minimum factor of safety that is consistent with the post-reclamation use proposed for the mining area.

Performance Standard 2.5-21: The grading of final slopes, the replacement soil, and associated erosion control measures shall take place prior to November 1 in areas where mining has been completed. To minimize erosion, the finish grading of mining pit slopes above the average seasonal high groundwater level, with the exception of the location of designated haul roads, shall be performed as soon as practical after the completion of mining of overburden and unsaturated aggregate resources. A drought-tolerant, weed-free mix of native and non-native grass species shall be established on slopes prior to November 1 or alternate erosion control (mulch or netting) shall be placed on exposed soil on the slopes prior to this date. Phasing of mining to minimize the length of exposed mining slopes during the rainy season is encouraged. ~~all slopes above the groundwater level shall be seeded with a drought-tolerant mix of native and non-native grass species, as soon as is practical after grading and prior to November 1. The grass seed mix shall be weed-free.~~

Implementation of the this mitigation measures would reduce this impact to a less-than-significant level for the OCMP and Alternatives 4, 5a, 5b, and 6.

Mitigation Measure 4.3-2b (A-2, A-3)

Local mining and reclamation regulations for mining operations outside the OCMP planning area shall adopt standards similar to Performance Standards 2.5-4, 2.5-17, 2.5-18, and 2.5-21 to control erosion during mining activities.

Implementation of this mitigation would reduce this impact to a less-than-significant level for Alternatives 2 and 3.

Mitigation Measure 4.3-2c (A-1a, A-1b)

None required.

Impact 4.3-3
Potential for Erosion from Surface Water Discharge, Including "Pit Capture"

The quality of the aggregate resources within and near the active channel of the creek and the relatively low cost of extraction has promoted in-channel mining within the planning area. These factors are likely to influence the prospecting for and development of off-channel mining. Applications for off-channel aggregate mining operations are likely to propose mining areas in positions as close to the creek channel as are permissible. The extraction of sand and gravel deposits during off-channel mining generally results in removal of a volume of subsurface materials that cannot be reasonably replaced. Therefore, the reclamation of mining pits usually results in a net lowering of the existing ground surface or creation of an open water lake if pits are excavated below and not filled to elevations above the groundwater table.

The modified topography associated with off-channel mining in areas adjacent to active creek channels can be affected by the creek processes, including flooding and erosion. Overbank flow during flooding can result in inundation of mining areas or reclaimed lands. The mined areas would fill to the elevation of the flood waters, resulting in localized, deeper flooding. Post-reclamation uses such as agriculture or habitat could be adversely affected by such flooding. Lowered reclamation areas, whether lakes or filled areas, would be surrounded by slopes that would cause increased flow velocity of flood waters. Under these conditions, significant erosion of the slopes can occur, potentially damaging reclamation features.

The erosion of slopes surrounding mined lands during flooding could potentially result in breaching of land separating the mined areas from the creek channel. If the separating land is eroded to an elevation similar to that of the creek bed, the channel flow in the creek could be diverted into the mined areas. The breaching of the separator could also result from slope failure or channel flow erosion of the separating land.

The instability of the channel of Cache Creek within the planning area was described in the Setting discussion. The channel bed has, throughout the planning area, incised between 10 to 20 feet below the position of the channel in 1905. The channel banks adjacent to the planning area are, in some areas, in excess of 25 feet high. In general, the stream banks are unstable, except in areas where slope grading or slope protection have been placed to improve stability and reduce erosion. The effectiveness of existing bank protection is variable, depending on the quality of the design and materials and the local hydraulic conditions. The major influence on the incision of the channel over this period has been reduction of channel width caused by construction of bridges, reclamation of in-channel areas for agriculture, excavation of the channel during aggregate mining, and construction of irrigation diversion structures.

Existing hydraulic conditions and historic trends indicate that some reaches of the creek currently have a high susceptibility for lateral migration and erosion of channel banks. Erosion of channel banks could remove or destabilize the land separating off-channel mining areas from the active creek channel. The creekside slopes of the separators or levees constructed on the separators could be oversteepened by erosion causing slope failure. Failed slope materials (landslide deposits) could be readily transported by the stream. A continued cycle of erosion and slope failure could eventually lead to total removal of the separator. In this situation, the creek could permanently "capture" the mined areas. This condition, referred to here as "pit capture" could cause significant channel bed destabilization. It should be noted that this type of uncontrolled pit capture resulting from an erosional event and/or slope failure differs from controlled pit capture. It is possible, with proper engineering design and construction, that levee segments could be modified to allow controlled pit capture during flood events.

If the creek channel were to migrate into and remain located in the captured pit, a localized overly steepened bed gradient, or nickpoint, would develop. Adjustment of the stream to this condition would result in erosion that would cause the nickpoint to migrate upgradient until a stabilized channel form developed. The migration of the nickpoint could cause erosion of important in-channel structures, such as bridges or irrigation diversion structures. Adjustments of the stream could also result in channel migration that could cause unexpected lateral erosion. Bank erosion could potentially result in loss of agricultural land or damage to creekside structures such as bridge abutments, habitat restoration projects, or, under some conditions, buildings, roadways, or irrigation canals.

The velocity and erosive power of the channel flow is controlled by the slope of the water surface. When confined to the channel, the slope of the channel flow is controlled by the slope of the channel bed and the geometry of the channel. At a given discharge, measured as flow volume per unit of time (e.g., cubic feet per second), a narrow, steep channel will create a higher flow velocity relative to a wide, gently sloping channel. As the channel flow, or a portion of the channel flow, is redirected into a lowered mined area, the velocity of the flow would be reduced as it spreads across and fills the flooded off-channel area. Once the flooded area is filled, the flood waters could flow to areas that are lower than the flood elevation. The flood water could be concentrated in existing stream channels or irrigation canals in the off-channel areas that have beds lower than the flood elevation. Under extreme conditions, the redirection of channel flow into mined areas could result in a permanent change in the position of the channel, or "stream capture." The potential for "stream capture" to be caused or initiated by the excavation of off-channel mining pits is remote due to the elevation of the terrace surfaces above the existing channel.

Draft OCMP and Implementing Ordinances

The Floodway and Channel Stability Element of OCMP acknowledges that instability of the Cache Creek channel could present conflicts with off-channel mining operations. The following policies relate to the compatibility of off-channel mining with the dynamic nature of Cache Creek:

Goal 4.2-1: Recognize that Cache Creek is a dynamic stream system that naturally undergoes gradual and sometimes sudden changes during high flow events.

Goal 4.2-2: Coordinate land uses and improvements along Cache Creek so that the adverse effects of flooding and erosion are minimized.

Goal 4.2-3: Establish a more natural channel floodway capable of conveying flood waters without damaging essential structures, causing excessive erosion, or adversely affecting adjoining land uses.

These Goals are supported in the OCMP by Actions 4.4-2, 4.4-3, and 4.4-6, and Performance Standards 4.5-1, 4.5-2, and 4.5-3, discussed below.

Action 4.4-2: Designate the streamway influence boundary described in the Technical Studies as part of the Off-Channel Mining Plan. The boundary describes the general area of the creek subject to meandering, as defined by the historic activities of the channel. The streamway influence boundary also defines the area where in-stream and off-channel issues overlap and are addressed in both plans.

This Action acknowledges the important relationship between the present boundaries of Cache Creek and the former historic positions of the creek. When the Streamway Influence Boundary (Figure 3.3-1) is compared to the present channel boundary (Figure 3.2-4), it is clear that over the historic period, the active channel of Cache Creek has been significantly narrowed and straightened. The general response of the creek has been to incise its bed, altering the hydraulics of the creek. This adjustment has resulted in changes in the hydraulic geometry (cross-section) and gradient of the stream. Continual adjustment of the stream is expected until a more stable channel configuration is established. This Action should be modified to acknowledge that any comparison of historic and current channel morphology should consider the longitudinal profile and cross-sections as well as the mapped position of the channel.

Action 4.4-3: Use the data and assumptions provided in the Technical Studies, when evaluating significant modifications to the flood plain. This will ensure a consistent frame of reference and will update the model to account for changing future conditions.

Action 4.4-3 is unclear with respect to what aspects of the Technical Studies' data and assumptions are being referred to or what types of modifications to the floodplain would be considered significant. The "model" referred to in the Action is not specified. The companion document to the OCMP, the Cache Creek Resource Management Plan, proposes a comprehensive program for the development of a more stable creek channel. The Technical Studies presented a conceptual model, referred to as the Test 3 Run, which identifies an area that should be considered in the development of a more stable channel configuration for the Cache Creek channel (Figure 4.3-5). The Technical Studies and the text of the OCMP acknowledge that an effective management strategy for development of a more stable channel will require periodic adjustments to the channel in response to changes along the creek. The Action shall be modified to specifically link consideration of off-channel mining within the CCRMP.

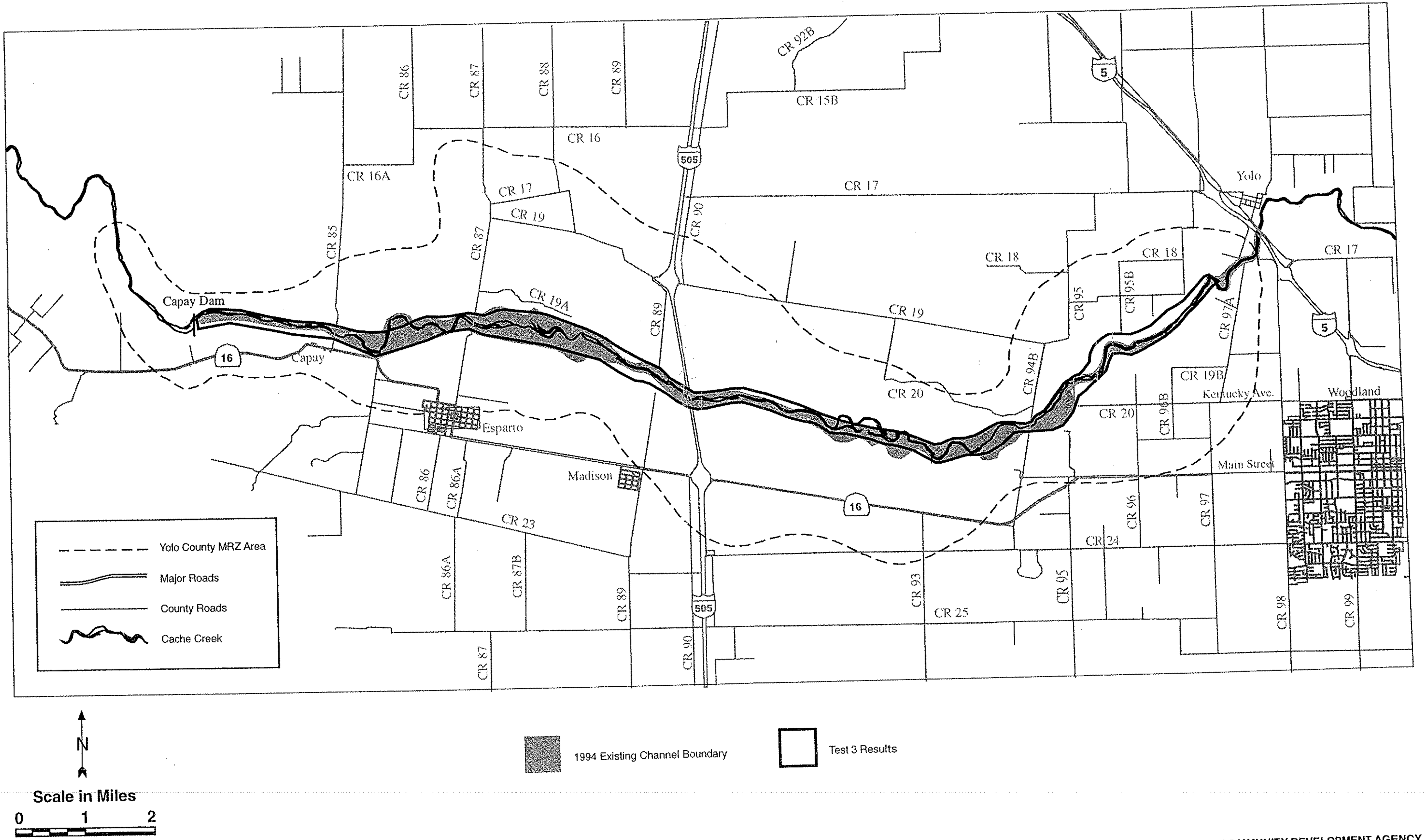

Figure 4.3-5 Test 3 Mobile Sediment Modeling Results

SOURCE: YOLO COUNTY COMMUNITY DEVELOPMENT AGENCY

Action 4.4-6 Allow for the design of spillways or other engineered features that provide controlled pit capture during a catastrophic flood event.

PS. 4.5-1: All off-channel surface mining operations shall be provided with a minimum one-hundred (100) year flood protection. Off-channel excavations that extend below the existing streambed elevation of Cache Creek shall be designed to minimize the possibility of levee breaching and/or pit capture, except under controlled circumstances.

Action 4.4-6 and Performance Standard 4.5-1 implicitly acknowledge that flood flow into pits during extreme high flow events could occur. The off-channel mining areas are required by Performance Standard 4.5-1 to be provided with 100-year flood protection. Mitigation of the potential of breaching of the separators and pit capture are provided by protection of inundation up to the level of a 100-year event and requirements for minimum setbacks from the channel for pits provided in Performance Standards 4.5-2 and 4.5-3. This level of protection assumes a reasonable level of risk (one percent) that the pits could be inundated. However, the potential for flooding during events larger (less frequent) than the 100-year event could cause erosion and possible breach of the separators between the pits and the creek, or between pits.

An important distinction should be made between allowing controlled pit capture and allowing flooding of mining pits. Pit capture, as defined earlier, would result in permanent connection between the pit and the creek. The consequences of this condition would be significant and could possibly cause destabilization of the creek channel. Controlled flooding of the pits during extreme events could help to prevent pit capture. Action 4.4-6 and Performance Standard 4.5-1 shall be modified to clarify this important point.

PS. 4.5-2: All off-channel excavations shall maintain a minimum two-hundred (200) foot setback from the existing active channel bank of Cache Creek.

PS. 4.5-3: Proposed off-channel excavations within the streamway influence boundary shall be set back a minimum of seven-hundred (700) from the existing channel bank, unless it is demonstrated in a manner consistent with the Technical Studies that a smaller distance will not adversely affect channel stability. Under no circumstances shall the setback be less than two-hundred (200) feet.

These performance standards set the minimum setback for off-channel mining areas from the active channel of Cache Creek. Performance Standard 4.5-2 could be eliminated because it is reiterated in Performance Standard 4.5-3. The 700-foot setback for areas within the streamway influence boundary is consistent with data presented in the Technical Studies indicating that large historic bank erosion events along Cache Creek during high flow events have been on the order of 200 to 800 feet. This magnitude of erosion could be expected in areas of adverse hydraulics and/or unstable and unprotected stream banks. The setback of 700 feet is appropriately conservative for most areas of the creek.

The Performance Standards imply that appropriate design of off-channel mining projects could provide sufficient protection against bank erosion to mining sites within 200 feet of the active channel. The magnitude of bank protection required to provide bank stability could vary significantly along the creek depending on the hydraulics of the stream in the vicinity of the stream. Bank protection solutions for individual off-channel mining projects could result in adverse hydraulic changes in areas of the stream in upstream or downstream position relative to those projects. The performance standard is unclear as to the specific analyses required for demonstrating that a project proposing mining within 700 feet and less than 200 feet of the active channel would not adversely affect channel stability. The Technical Studies present critical information regarding the current hydraulic conditions along the creek but do not present guidelines for design of bank protection. This performance standard shall be modified to define the level of analysis that should be presented for the design of these projects. In addition, a performance standard that establishes a means for maintaining adequate bank protection shall be added to the OCMP.

Alternative 1a: No Project (Existing Conditions) and
Alternative 1b: No Project (Existing Permits and Regulatory Condition)

Off-channel and in-channel mining would continue to occur under these alternatives and would be regulated by existing ordinances and regulations. The potential for erosion of the separators between mined off-channel pits is not specifically addressed by these regulations. However, the potential for failure of the separators was addressed in technical studies prepared for the currently permitted operations and in the environmental review of these projects. Therefore, the potential impact of pit capture was mitigated for these projects and no further mitigation is required.

Alternative 2: No Mining (Alternative Site) and
Alternative 3: Plant Operation Only (Importation)

Under these alternatives no off-channel mining would occur in the planning area. Therefore mitigation of the potential impacts of pit capture on off-channel mining areas would not occur and mitigation of the impact would not be necessary.

Alternative 4: Shallow Mining (Alternative Method/Reclamation),
Alternative 5a: Decreased Mining (Restricted Allocation),
Alternative 5b: Decreased Mining (Shorter Mining Period), and
Alternative 6: Agricultural Reclamation (with Mining Operations as Proposed)

Under each of these alternatives, off-channel mining to depths below the bed of Cache Creek could occur. The potential impact of bank erosion and failure of separators could occur. The number of pits potentially affected by the impact could be reduced under these alternatives, however, the impact for pit capture would remain significant.

Mitigation Measure 4.3-3a (OCMP, A-4, A-5, A-6)

The following text shall be added to Action 4.4-2:

> *Action 4.4-2: Designate the streamway influence boundary described in the Technical Studies as part of the Off-Channel Mining Plan. The boundary describes the general area of the creek subject to meandering, as defined by the historic activities of the channel. The streamway influence boundary also defines the area where in-stream and off-channel issues overlap and are addressed in each both plans. Whereas the streamway influence boundary shall be recognized as representative of historic conditions, the current hydraulic conditions of creek shall be considered in decision-making regarding channel and floodplain management.*

Action 4.4-3 from the OCMP shall be replaced by the following action:

> *Action 4.4-3: Evaluation of proposed significant modifications to the flood plain, including off-channel mining areas, shall be made with reference to the channel improvement strategy and guidelines presented in the Cache Creek Resource Management Plan. This will ensure a consistent frame of reference and allow consideration of such modifications in the context of an integrated creek management program.*

Action 4.4-6 shall be amended as follows:

> *Action 4.4-6: Allow for the design of spillways or other engineered features that provide controlled ~~pit capture during a catastrophic flood event~~ flooding of off-channel mining pits during flood events which exceed the 100-year flood event.*

Performance Standard 4.5-1 shall be amended as follows:

> *Performance Standard 4.5-1: All off-channel surface mining operations shall be provided with a minimum one-hundred (100) year flood protection. Off-channel excavations that extend below the existing streambed elevation of Cache Creek shall be designed to minimize the possibility of levee breaching and/or pit capture~~, except under controlled circumstances~~.*

Performance Standard 4.5-2 shall be deleted from the OCMP.

Performance Standard 4.5-3 shall be amended as follows:

> *Performance Standard 4.5-3: Proposed off-channel excavations within the streamway influence boundary shall be set back a minimum of seven-hundred (700) from the existing channel bank, unless it is demonstrated ~~in a manner consistent with the Technical Studies~~ that a smaller distance will not adversely affect channel stability. Under no circumstances shall the setback be less than two-hundred (200) feet. The evaluation of the potential for adverse effects of bank erosion or failure of the land separating pits located less than 700 feet from the active channel shall include, at minimum, the following analyses:*
>
> - *The 200-foot setback area shall not include portions of the former historic active floodplain or formerly mined lands separated from the active channel by levees or unmined areas less than 200 feet wide (measured perpendicular to the active channel).*

- *Identification of the former historic positions of the Cache Creek channels as delineated in the CCRMP Technical Studies, and determination if proposed project is located within the limits of the historic channel;*
- *Description of current channel hydraulic conditions (based on existing or site-specific hydraulic models) for the Cache Creek channel adjacent to the site and extending not less than 1,000 feet upstream and downstream of the site;*
- *Determination of erosion potential of stream bank adjacent to the site made on the basis of stream flow velocity and estimated shear stress on bank materials during 100-year flood flows and historic patterns of erosion;*
- *Analytical slope stability analysis in conformance with Performance Standards 2.5-16 and 2.5-18. This slope stability analysis of the slopes separating the mining area from the creek channel shall include evaluation of stability conditions during 100-year flood flows in the channel;*
- *Future proposed bank stabilization designs, if recommended, shall not conflict with channel design recommendations of the Cache Creek Resource Management Plan unless approved by the Technical Advisory Committee.*

The following Performance Standards shall be added to the OCMP and implementing ordinances:

> *Performance Standard 4.5-8: Financial assurances for off-channel mining operations which include mining within 700 feet of the active channel of Cache Creek shall include adequate funding for maintenance during the mining and reclamation period of any bank stabilization features approved for the mining permit. Maintenance of the bank stabilization features following the completion of reclamation shall be the responsibility of the property owners under the Cache Creek Resource Management Plan.*

Implementation of these mitigation measures would reduce this impact to a less-than-significant level for the OCMP and Alternatives 4, 5a, 5b, and 6.

Mitigation Measure 4.3-3b (A-1a, A-1b, A-2, A-3)

None required.

Impact 4.3-4
Decreased Availability of Aggregate Resources

The availability and quality of recognized aggregate resources with the lower Cache Creek basin would likely encourage commercial interest in in-channel and/or off-channel aggregate resource extraction. Continued sand and gravel extraction in the lower Cache Creek basin would result in depletion of the remaining raw aggregate resources. Mining of in-channel resources at historic or current rates would exceed the replenishment rate for these resources. The in-channel resources are replenished by the transportation and deposition of aggregate by Cache Creek. The current sand and gravel sediment yield along the creek within the reach of Cache Creek surrounded by the planning area has been estimated to be 210,000 tons per year (NHC, 1995). This estimate represents only the amount of sediment that enters this area of the creek, not necessarily the amount of sediment deposited annually.

Off-channel mining would result in extraction of resources that would not be replenished within normal planning horizons (less than 100 years). Under current conditions, the creek in this area is incised below the valley floor. Therefore, sand and gravel deposition within the planning area would be negligible. Although sand and gravel are produced continually through the process of erosion, the sand and gravel resources removed from off-channel mining pits on the alluvial terraces within the planning area are not expected to be replaced in the foreseeable future.

SMARA includes provisions for the development and conservation of mineral resources. The development of aggregate materials includes mining, processing, and distribution of mineral resources. The concept of conservation is not clearly defined by SMARA. The Act provides for protection of identified aggregate resources from incompatible land uses. However, SMARA does not specify that the extraction of the resources be required or controlled to extend the availability of the resource.

Aggregate resources are not "non-renewable" in that the production of aggregate products, such as concrete, asphaltic concrete, and road base, does not generally result in the destruction of the aggregate. The aggregate resources in these products remain durable during most types of uses and are potentially reusable through recycling. In addition, mining and processing of other rock sources, including rock produced through mining of bedrock in quarries or mining of lower quality alluvial deposits, can provide aggregate for similar uses. However, the processing necessary to produce the appropriate physical properties (suitable grain sizes and rock fragment shapes) for use of these sources as PCC-grade aggregate is relatively expensive compared to use of alluvial sand and gravel, such as those within the OCMP planning area. In addition, no suitable sources of quarry rock have been identified within Yolo County.

Aggregate resources are necessary for construction materials for buildings, bridges, canals, and pavements. The demand for aggregate within the Sacramento-Fairfield Production-Consumption Region (S-FP-CR) that includes Yolo County for the period 1983 to 2033 was estimated by CDMG to be 888.6 million tons (17.7 million tons per year) to meet all aggregate needs. Approximately 40 percent (355.2 million tons) of the total aggregate demand was historically used as PCC-grade aggregate. The Yolo County OCMP estimates that the production of aggregate within the planning area over the period 1997 to 2047 would be 289 million tons if the area were to continue to meet 26 percent of the regional demand.

If extraction of aggregate in the planning area were to meet the this demand for aggregate, the rate of extraction would be approximately 5.8 million tons per year. Production at this rate, assuming an aggregate replenishment rate of 210,000, would exhaust the known reserves in the project site in approximately 140 years. The aggregate extraction rate could be reduced and the period over which the resource would remain available could be extended by:

- recycling of aggregate products;
- supplementing aggregate resources with other recycled products, such as glass;
- conservation of PCC-grade aggregate for PCC production only.

Although these measures could be partially effective in reducing the demand for raw aggregate, Yolo County does not have the authority to control the products or types of products made available by the aggregate industry that are safe and meet current standard specifications.

Draft OCMP and Implementing Ordinances

The OCMP promotes a shift in the emphasis of aggregate resources from in-channel mining operations to off-channel operations to provide for more stable conditions along the Cache Creek channel while allowing development of the valuable aggregate resources. The effect of eliminating commercial in-channel mining would result in the continued preservation of approximately 111 million tons of PCC-grade aggregate located below the creek channel. The Cache Creek Resource Management Plan proposes the only extraction of aggregate within the channel will be related to maintenance of a more stable channel. These activities would not be expected to excavate a significant amount of aggregate from below the theoretical thalweg. Although the availability of these deposits may be limited by competing or conflicting land use values, such as protection of stream stability or habitat resources, future use of the resources for production of aggregate products is not precluded.

The mining of off-channel resources that could be permitted under the OCMP will result in a decrease in the availability of aggregate resources in the future. The aggregate mining operations currently identified as foreseeable under the period considered under the OCMP could result in the extraction of approximately 179 million tons. Under the OCMP, the County has also been requested to designate an additional 676 acres of land within the MRZ-2 zones in the planning area with a Sand and Gravel Reserve (SGR) overlay. Mining of these areas could result in extraction of an additional 136.5 million tons in the period 30 to 50 years in the future. If approved, the requested projects (including in-channel gravel extracted for channel stability improvements under the CCRMP) and rezoning and assumed extraction at the Schwarzgruber site could result in extraction of a total of 216 million tons of aggregate from the project within the next 50 years. This amount represents approximately 24 percent of the combined estimated 807 million tons of off-channel aggregate and 111 million tons of in-channel aggregate (918 million tons total) available within the planning area. The remaining 702 million tons of aggregate could be used if needed and made available to provide aggregate resource for an additional 121 years (assuming a production rate of 5.8 million tons per year).

The potential availability of existing aggregate resources that would not be mined under the OCMP and the potential reuse and supplementation of aggregate resources indicate that the impact of decreased availability of aggregate due to potential mining under the OCMP is a less-than-significant impact of the proposed project.

Alternative 1a: No Project (Existing Conditions) and Alternative 1b: No Project (Existing Permits and Regulatory Condition)

Under these alternatives, a maximum of approximately 19 million tons of aggregate would be extracted from the planning area over the next 8 years. This total tonnage represents approximately 2 percent of the estimated total resources (918 million tons) within the planning area. The remaining unmined tonnage, 844 million tons would be available, if needed, for future use. The potential for depletion of the aggregate reserves under this alternative is a less-than-significant impact.

Alternative 2: No Mining (Alternative Site) and Alternative 3: Plant Operation Only (Importation)

No mining would occur within the planning area under these alternatives. Therefore, the potential for depletion of the aggregate reserves in the lower Cache Creek basin would be a less-than-significant impact. It is assumed under Alternative 2 that 65 million tons of processed materials would need to be imported from elsewhere to satisfy demand. It is assumed under Alternative 3 that 113 million tons of raw materials would likely be imported for processing at local plants. Depletion of resources under these two alternatives would occur outside the OCMP planning area.

Alternative 4: Shallow Mining (Alternative Method/Reclamation)

Under this alternative, approximately 34 million tons of aggregate would be extracted in shallow mining operations from the planning area over the next 30 years. This total tonnage represents less than 4 percent of the estimated total resources (918 million tons) within the planning area. The remaining unmined tonnage, 884 million tons would be available, if needed, for future use. The potential for depletion of the aggregate reserves under this alternative is a less-than-significant impact.

Alternative 5a: Decreased Mining (Restricted Allocation)

Under this alternative, the extraction of aggregate would be limited to 2.3 million tons per year for the next 30 years. The maximum total extraction (66 million tons) would be approximately 7 percent of the total resources in the planning area. Approximately 852 million tons would be available for future use and the impact of depletion would be less than significant.

Alternative 5b: Decreased Mining (Shorter Mining Period)

The extraction of aggregate within the planning area under this alternative would be 110 million tons or 12 percent of the total estimated resources within the planning area. This alternative would present a less-than-significant potential impact of depletion of the aggregate resources.

Alternative 6: Agricultural Reclamation (with Mining Operations as Proposed)

The total tonnage of aggregate removed under this alternative would be approximately 180 million tons over 30 years or 20 percent of the total estimated reserves within the planning area. Similar to the proposed project, the impact of the extraction would be less than significant.

Mitigation Measure 4.3-4a (OCMP, A-1a, A-1b, A-2, A-3, A-4, A-5, A-6)

None required.